REMEDIAL INVESTIGATION FEASIBILITY STUDY (RI/FS) WORK PLAN REVISION: 01

ASHLAND/NSP LAKEFRONT SUPERFUND SITE

ASHLAND, WISCONSIN

February 2004

URS
54 Park Place, Suite 950
Appleton, Wisconsin 54914
(920) 968-6900

URS Project No. 25687954

Ashland/NSP Lakefront Site – BRRTS# 02-02-000013

List of Tables, Figures, and Appendices

Tables

Figures

Appendices

List of Abbreviations

AC	Area of Concern
ADD	Average Daily Dose
ANCOVA	Analysis of Covariance
AVS:SEM	Acid Volatile Sulfildes
AOC	Administrative Order on Consent
ARAR	Applicable or Relevant and Appropriate Requirement
ASTM	American Society of Testing Materials
ATSDR	Agency of Toxic Substance and Disease Registry
AWQC	Ambient Water Quality Criteria
BERA	Baseline Ecological Risk Assessment
BETX	Benzene, Ethylbenzene, Toluene, and Xylene
bgs	below ground surface
BTU	British Thermal Unit
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
ch. NR 140	Wisconsin Admim. Code Chapter NR 140 - Groundwater Quality
ch. NR 720	Wisconsin Admim. Code Chapter NR 720 - Soil Cleanup Standards
ch. NR 722	Wisconsin Admim. Code Chapter NR 722 - Standards for Selecting Remedial Actions
CFR	Code of Federal Regulations
COC	Compounds of Concern
CSTAG	Contaminated Sediment Technical Advisory Group
CTE	Central Tendency Exposure
CV	Critical Value
DCA	Decision and Consequence Analysis
D&M	Dames & Moore Inc.
DCOM	Wisconsin Department of Commerce
DHFS	Department of Health and Family Services - State of Wisconsin
DMP	Data Management Plan
DNAPL	Dense Non-aqueous Phase Liquid
DW	Dry Weight
DQO	Data Quality Objective
EPA	Environmental Protection Agency (USEPA)
EPC	Exposure Point Concentration
ERA	Ecological Risk Assessment
ERAGS	Risk Assessment Guide for Superfund Sites
ERM	Effects Range - Median
ES	Enforcement Standard per Wisconsin Administrative Code ch. NR 140
ESA	Environmental Site Assessment
eV	Electron-volt
FS	Feasibility Study for Remedial Action Options

FSP	Field Sampling Plan
GIS	Geographic Information System
GLI	Great Lakes Initiative
GTI	Gas Technology Institute (f.n.a. IGT)
HA-28	*Hyallela azteca* 28 day Toxicity Test
HASP	Health and Safety Plan
HEAST	Health Effects Assessment Summary Tables
HHRA	Human Health Risk Assessment
HQ	Hazard Quotient
IGT	Institute of Gas Technology (n.k.a, GTI)
IRIS	Integrated Risk Information System
LOAEL	Lowest Observed Adverse Effects Level
LOEC	Lowest Observed Effects Concentration
LSDP	Lake Superior District Power
LNAPL	Light Non -aqueous Phase Liquid
mg/kg	milligram/kilogram
mg/L	milligram/liter
MCL	Maximum Contaminant Level
MDD	Minimum Detectable Difference
MDL	Maximum Detection Limit
MGP	Manufactured Gas Plant
MSA	Mid-States Associates, Inc.
MSL	Mean Sea Level
MVUE	Minimal Variance Unbiased Estimate
NAPL	Non Aqueous Phase Liquid
NCP	National Oil and Hazardous Substance Pollution Contingency Plan
NET	Northern Environmental Technologies, Inc.
NLS	Northern Lake Service, Inc.
NOAA	National Oceanic and Atmospheric Administration
NOAEL	No Observed Adverse Effects Level
NOEC	No Observed Effects Concentrations
NPL	National Priorities List
NRDA	Natural Resource Damage Assessment
NSE	No Standard Established
NSP	Northern States Power Company
O&M	Operation and Maintenance
OMM	Operations Maintenance and Monitoring
ORNL	Oak Ridge National Lab
OSC	On Scene Coordinator
OSWER	Office of Solid Waste and Emergency Response
PAH	Polycyclic Aromatic Hydrocarbons
PAL	Preventive Action Limit per Wisconsin Administrative Code ch. NR 140
PE	Professional Engineer

PEL	Probable Effects Level
PG	Professional Geologist
PID	Photo-ionization Detector
PMP	Project Management Plan
ppb	parts per billion
PPE	Personal Protective Equipment
ppm	parts per million
PQL	Practical Quantitation Limit
PRG	Preliminary Remediation Goal
PRP	Potential Responsible Party
PVOCs	Petroleum Volatile Organic Compounds
QAPP	Quality Assurance Project Plan
RAGS	Risk Assessment Guide for Superfund Sites
RAOR	Remedial Action Options Report
RBSC	Risk Based Screening Concentrations
RCL	ch NR 720 Residual Contaminant Level
RfC	Reference Concentrations
RfD	Reference Dose
RI	Remedial Investigation
RL	Reporting Limits
RME	Reasonable Maximum Exposure
ROC	Receptors of Concern
ROD	Record of Decision
RPM	Regional Project Manager
SEH	Short Elliott Hendrickson Inc.
SOEI	Sigurd Olsen Environmental Institute
SOW	Scope of Work
SSL	Soil Screening Level
STL	Severn Trent Laboratories, Inc.
SVE	Soil Vapor Extraction
SVOC	Semi-volatile Organic Compounds
SQL	Sample Quantiation Limit
TIC	Tentatively Identified Compounds
TCLP	Toxicity Characteristic Leaching Procedure
TLR	Technical Letter Report
TOC	Total Organic Carbon
TOSC	Technical Outreach Service for Communities
TPAH	Total Polycyclic Aromatic Hydrocarbons
TRV	Toxicological Reference Values
TSCA	Toxic Substances Control Act
TSS	Total Suspended Solids
UCL	Upper Control Limit
µg/kg	microgram/kilogram

μg/L	microgram/liter
URS	URS Corporation
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UV	ultraviolet
VOC	Volatile Organic Compound
WAC	Wisconsin Administrate Code
WCL	Wisconsin Central Limited
WDNR	Wisconsin Department of Natural Resources
WPDES	Wisconsin Pollution Discharge Elimination System
WWTP	Waste Water Treatment Plant

EXECUTIVE SUMMARY

The Ashland NSP Lakefront Superfund Site (the "Site") consists of approximately 20 acres of affected land and sediment located along the shore of Lake Superior, in Ashland, Wisconsin. The Site contains property owned by Northern States Power Company (NSP), a Wisconsin corporation (d.b.a. Xcel Energy, a subsidiary of Xcel Energy, Inc. ("Xcel Energy")), a portion of Kreher Park, a City owned property fronting on the bay, the former City Waste Water Treatment Plant (WWTP), also located at Kreher Park, and an inlet area containing contaminated sediment directly offshore from the former WWTP. The Xcel Energy property, located on an upland area above a bluff face fronting on Kreher Park, is the site of a former manufactured gas plant (MGP) that operated between 1885 and 1947. Kreher Park includes reclaimed lands from the bay filled during the 1800s when the area was the site of major lumbering operations. The most significant of these operations was the John Schroeder Lumber Company, which operated a sawmill, a planing mill, a wood treatment facility and a shipping facility on the lakefront between 1900 and 1939.

The site includes four areas of concern (ACs). These include: the upper bluff/filled ravine (AC 1) on the Xcel Energy property that formerly opened to the lakeshore, the Copper Falls (AC 2), a deep confined aquifer, separated from the near surface fill soils by the Miller Creek Formation, a silty clay aquitard; Kreher Park and the former WWTP (AC 3); and the affected offshore sediments (AC 4). The primary contaminants at each operable unit are coal tar-like compounds, volatile organic compounds (VOCs) and polycyclic aromatic hydrocarbons (PAHs). The most abundant compound from each of these compound groups includes benzene and naphthalene. Soils and groundwater contaminated with these compounds are present at ACs 1 and 3. In addition, free-product coal tar present as a dense non-aqueous phase liquid (DNAPL) is found in the upper reaches of the ravine on the Xcel Energy property, and formerly was found at Kreher Park where an underground clay tile that extended the length of the ravine intermittently discharged at the surface at the former "seep" area of the Park. Free-product coal tar is also found in the upper deposits of the Copper Falls Aquifer (AC 2). This free-product has resulted in a dissolved phase plume that extends north from the area of the free-product in the direction of groundwater flow, toward and beneath the Bay. However, the Miller Creek Formation prevents cross-contamination from AC 2 to AC 3 and AC 4. Artesian pressures measured at the ground surface at Kreher Park in wells screened in the Copper Falls Aquifer confirm that this aquifer is hydraulically separate from the Kreher Park fill and sediments.

Free-product is also present in the sediments. The area of affected sediments covers approximately 10 acres. It is within these sediments where the highest contaminant levels of VOCs and PAHs have been found.

The Wisconsin Department of Natural Resources (WDNR) first began investigating the Site in 1994. The Agency formally notified Xcel Energy of its responsible party status in 1995. Since that time, Xcel Energy has performed several subsurface investigations of ACs 1 and 2. The company has also implemented interim remedial actions for both of these areas. A low-flow product removal system is currently extracting free-product from the Copper Falls Aquifer, and treating the entrained groundwater prior to discharge to the City's sanitary sewer. Additionally, Xcel Energy installed an extraction well at the base of the filled ravine near its former mouth to prevent contaminated groundwater from continuing to migrate from the ravine to the Kreher Park area. This well collects groundwater and discharges it to the existing coal tar recovery and treatment system. The installation of this extraction well was part of a larger interim action that included excavation of contaminated materials at a former seep area, and placement of a low-permeability cap to eliminate the intermittent seep discharge and to mitigate environmental exposure of the associated contaminants.

The WDNR has concurrently investigated the Kreher Park area and the affected bay sediments. Parts of these efforts have included preparation of Baseline Human Health and Ecologic Risk Assessments (HHRA and BERA) on these affected areas. These studies have concluded that the contamination at the lakefront causes an unacceptable risk to human health and the environment. The WDNR also concluded that the primary source of the contamination is the former MGP. Consequently, Xcel Energy has presented information including eyewitness and deposition testimony, historical documentation and technical data that confirm the presence of Schroeder Lumber's wood treatment operations, indicating multiple sources of contamination.

During the execution of these studies by both the WDNR and Xcel Energy in 1999, a private citizen petitioned USEPA to consider scoring the site for inclusion on the National Priorities List (NPL). The site was nominated for inclusion on the NPL in December, 2000, and formally listed in September 2002. During the listing period, USEPA entered into a Cooperative Agreement with WDNR to fund the remedial investigation / feasibility study (RI/FS) that is required as part of the NPL process. This Agreement allowed WDNR to contract with Short Elliott Hendrickson Inc. (SEH) to prepare a work plan for an RI/FS at the site. Subsequently, a series of technical meetings were held during the fall and winter of 2002/2003 among representatives of the two agencies and Xcel Energy to discuss plans to complete the RI portions of the program. During this same time, Xcel Energy began discussions with USEPA and WDNR regarding work that the company was prepared to implement.

Following discussions with USEPA in May and June 2003, USEPA sent a General Notice letter and proposed Administrative Order on Consent (AOC) with an attached Statement of Work (SOW) to Xcel Energy on August 8, 2003. Xcel Energy subsequently submitted a good faith offer/letter of intent on August 22, 2003 along with Revision 00 of this Remedial Investigation/Feasibility Study (RI/FS) Work Plan, developed as part of the proposed AOC/SOW. Following negotiations in September and October, 2003 the AOC was formally executed on November 14, 2003.

During the AOC negotiations, USEPA conditionally approved the portion of the Revision 00 work plan and associated Quality Assurance Project Plan (QAPP) addressing the subsurface investigation of the upper bluff/filled ravine and Copper Falls Aquifer ACs. Because the effective date of the AOC coincided with the onset of winter weather, Xcel Energy committed to install three piezometers on its property and one on the Our Lady of the Lake property located on the adjacent property to the west. These wells were installed during December, 2003. Samples from these wells were collected as part of the ongoing monitoring for the interim tar removal system.

SEH completed its obligations under its contract with the WDNR with submittal of an alternative Remedial Investigation Work Plan on October 31, 2003. The AOC specified that Xcel Energy consider investigation activities proposed in the SEH plan, and incorporate those activities as appropriate in its Revision 01 work plan. Prior to preparing this document, the AOC required that Xcel Energy submit a Technical Letter Report (TLR) comparing the two work plans. This TLR was to serve as the basis for a technical scoping meeting held between the agencies and Xcel Energy, which would culminate in a USEPA meeting summary, followed by the Revision 01 work plan. The TLR was submitted on December 12, 2003, and the technical scoping meeting was held on January 8, 2004. Xcel Energy received the meeting summary on January 19, 2004. This Revision 01 work plan meets the submittal requirements as specified in the AOC. The scope of work for the remedial investigation described herein is consistent with the AOC and the latest discussions with USEPA. It consists of the following:

- Preparing site specific plans including this Revision 01 Work Plan, a field sampling plan (FSP), quality assurance project plan (QAPP), health and safety plan (NSP), and a project management plan (PMP);

- Collecting surface and subsurface soil samples from borings advanced in the vicinity of the former MGP to further characterize the lateral and vertical extent of contamination at AC 1 south of St. Claire Street;

- Collecting six rounds of groundwater samples from wells installed in the filled ravine/upper bluff to characterize groundwater conditions at this AC;

- Conducting an air emission investigation in the filled ravine and adjacent structures to evaluate the potential inhalation pathway for exposure to potential vapors generated at the site;

- Installing additional piezometers in the Copper Falls Aquifer, and collecting six rounds of groundwater samples from Copper Falls piezometers, to further characterize the lateral and vertical extent of groundwater contamination at AC 2;

- Conducting a borehole geophysical survey to verify subsurface geologic units, and performing a visual (downhole camera) inspection of two artesian wells open to the Copper Falls Aquifer at Kreher Park;

- Conducting exploration test pits and collecting soil samples at AC 3 to characterize the uncontrolled solid waste disposal area and former wood treatment/coal tar "dump" area;

- Collecting soil samples from borings advanced at Kreher Park in the vicinity of the former seep area and monitoring well TW-11 to characterize free-product measured at these locations; also collecting soil samples from borings advanced in utility corridors and (as needed) the former solid waste disposal area and former wood treatment area to further characterize the lateral and vertical extent of contamination at the Park area;

- Installing additional monitor wells and collecting six rounds of groundwater samples at Kreher Park to evaluate the interrelationship between groundwater and contaminants in the fill at the Park and the affected sediments; and

- Conducting a baseline human health risk assessment using data generated from all ACs.

In accordance with agreements made at the Technical Scoping meeting, two alternatives are presented for the investigation of the affected sediments. The first of these includes the following sampling design strategy:

- Implementing a sediment Triad design sampling strategy that will evaluate chemical, biological and toxicological indices for sediment dwelling organisms; these lines of evidence supplement traditional sediment analytical data; the Triad design strategy will consist of applying the chemical, biological and toxicological data derived from studies of the benthic community, pore-water and sediment chemistry and substrate toxicity to provide a site-specific risk assessment. A total of 12 sampling stations within the affected area, along with four reference stations outside the area are tentatively recommended (a reconnaissance survey will be initially performed to finalize sample stations);

- Collecting fish tissue to support a baseline human health risk assessment;

- Implementing sediment stability analyses that will include both a quantitative (modeling) and an empirical evaluation of sediment stability as recommended by USEPA; the purpose of this study will be to determine if existing sediment is naturally being eroded or buried; the results of the study will be used to apply to remedial analyses; and

- Conducting a baseline ecological risk assessment integrating the data developed from the triad studies to further define the nature and extent of contamination from contaminants of concern (COCs) to historical sources.

The second alternative for study of the affected sediments recommends implementation and continuation of a problem formulation process with the active participation of all affected stakeholders. This process has been recommended both by USEPA in its recent Management of

Contaminated Sediment Sites guidance (2002) and by USEPA's Contaminated Sediment Technical Advisory Group (CSTAG) following its Ashland visit in July 2002. As outlined, this approach recommends convening stakeholders in a series of workshops with the intent of finalizing a sampling strategy that will satisfy all parties.

Xcel Energy recommends that USEPA approve the second alternative for the sediments investigation program for the remedial investigation. The attached schedule indicates that the Draft RI report will be submitted to USEPA in the same duration regardless of the sediments investigation alternative approved.

The majority of the field work for the remedial investigation will be completed during the 2004 field season. Submittal of the RI report will follow analyses and evaluation of the final round (sixth round) of groundwater sample collection. Following this submittal and in conformance with the AOC, Xcel Energy will develop and screen remedial options, and submit a series of technical memoranda prior to submittal of the Feasibility Study (FS) Report. The first will be a Remedial Action Objectives Technical Memorandum submitted to USEPA for approval within 30 days of submittal of the Draft RI report. Following USEPA review and comment on this first technical memo, an Alternatives Screening Technical Memorandum will be submitted. This memo will be accompanied, if not submitted earlier, by a Candidate Technologies and Testing Needs Technical Memorandum if treatability testing is considered necessary. (In that event, a Treatability Testing Work Plan along with a SAP (or amendments to the appropriate original planning documents to that effect) will be submitted outlining the treatability testing program. The studies will culminate in a Treatability Study Evaluation Report.) A Comparative Analysis of Alternatives Memorandum will be the final technical memo submitted evaluating and analyzing alternatives. Following USEPA's review of the final technical memo, the FS Report will be submitted. Based upon the attached schedule, the FS report should be submitted within approximately two years (excluding treatability testing, if required) of approval of this work plan.

In addition to the above deliverables, Xcel Energy will prepare and submit monthly reports on the 15th of every month describing project activities completed during the previous calendar month. As of the submittal of this Revision 01 Work Plan, Xcel Energy has submitted three of these reports, beginning December 15, 2003.

1.0 INTRODUCTION

1.1 PURPOSE

This remedial investigation / feasibility study (RI/FS) work plan has been prepared to describe the site setting, background, contaminant conditions and proposed sampling plan for completion of the RI/FS at the Ashland/NSP Lakefront Superfund Site (the "Site"). This work plan is intended to fulfill on of the requirements of the Administrative Order on Consent (AOC) executed between Xcel Energy and the United States Environmental Protection Agency (USEPA) on November 14, 2003. This document also meets the standards described in *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA,* USEPA, October, 1988.

1.2 OBJECTIVES

The overall goal of the RI/FS process is to collect sufficient data to characterize the extent of contamination at the Site and provide the basis for completion of a feasibility study setting forth a range of potential remedial options leading to the Agency's selection of a proposed remedial action for the Site. Site investigation data developed in accordance with this work plan will be used in conjunction with historic investigation data to evaluate potential exposure pathways and develop potential remedial alternatives protective of human health and the environment. Specific objectives of the RI/FS include the following:

- Identify hazardous substances released to the environment and develop a list of these constituents of concern;
- Identify the vertical and lateral extent of coal tar present as dense non-aqueous phase liquids (DNAPL);
- Identify the vertical and lateral extent of soil and groundwater contamination at the Site;
- Identify potential hazardous air contaminants and associated exposure pathways;
- Identify and characterize the extent of contamination in sediments at the Site;

- Identify potential migration pathways for constituents of concern;

- Identify potential receptors for constituents of concern;

- Use previously developed data of sufficient quality for site characterization, risk assessment, and selection of proposed remedial alternatives;

- Evaluate potential risk to human health and the environment; and

- Develop a range of remedial alternatives to address potential threats to human health and the environment.

The results of this evaluation will be described in a series of reports and technical memoranda that will allow the Agency to develop a Record of Decision (ROD) for the Site.

2.0 SITE BACKGROUND AND SETTING

2.1 SITE BACKGROUND

2.1.1 Site Description

The Site consists of property owned by Northern States Power Company, a Wisconsin corporation (d.b.a. Xcel Energy, a subsidiary of Xcel Energy, Inc. ("Xcel Energy")) a portion of Kreher Park, and sediments in an offshore area adjacent to Kreher Park[1]. The Site is located in S 33, T 48 N, R 4W in Ashland County, Wisconsin, shown on Figure 1. Existing site features showing the boundary of the site are shown on Figure 2. The location of existing wells and borings used to define subsurface conditions are shown on Figures 3 and 4.

The Xcel Energy facility is located at 301 Lake Shore Drive East in Ashland, Wisconsin. The facility lies approximately 1,000 feet southeast of the shore of Chequamegon Bay of Lake Superior. The Xcel Energy property is occupied by a small office building and parking lot fronting on Lake Shore Drive, and a larger vehicle maintenance building and parking lot area located south of St. Claire Street between Prentice Avenue and 3rd Avenue East. There is also a gravel parking and storage yard area north of St. Claire Street between 3rd Avenue East and Prentice Avenue, and a second gravel storage yard at the northeast corner of St. Claire Street and Prentice Avenue. A large microwave tower is located on the north end of the storage yard. The office building and vehicle maintenance building are separated by an alley. The area occupied by the buildings and parking lots is relatively flat, at an elevation of approximately 640 feet above mean sea level (MSL). Drainage from the Xcel Energy property is to the north. Residences bound the site east of the office building and the gravel parking area. Our Lady of the Lake Church and School is located immediately west of Third Avenue East. Private homes are located immediately east of Prentice Avenue. To the northwest, the site slopes abruptly to the Wisconsin Central Limited Railroad property at a bluff that marks the former Lake Superior shoreline, and then to the City of Ashland's Kreher Park, beyond which is Chequamegon Bay.

[1] Reference to this portion of the Site as Kreher Park developed colloquially over the course of this project. Kreher Park consists of a swimming beach, a boat landing, an RV park and adjoining open space east of Prentice Avenue, lying to the east of the subject study area of the Site. For purposes of this work plan and to be consistent with past reports referenced in this plan, the portion of the Site to the west of Prentice Avenue, east of Ellis Avenue and north of the NSP property is referred to as the "Kreher Park Area" or simply Kreher Park.

The impacted area of Kreher Park consists of a flat terrace adjacent to the Chequamegon Bay shoreline. The surface elevation of the park varies approximately 10 feet, from 601 feet MSL, to about 610 feet MSL at the base of the bluff overlooking the park. The bluff rises to an elevation of about 640 feet MSL, which corresponds to the approximate elevation of the Xcel Energy property. The lake elevation fluctuates about two feet, from 601 to 603 feet MSL. At the present time, the park area is predominantly grass covered. A gravel overflow parking area for the marina occupies the west end of the property, while a miniature golf facility formerly occupied the east end of the site. The former City of Ashland waste water treatment plant (WWTP) and associated structures fronts the bay inlet on the north side of the property. The impacted area of Kreher Park is bounded by Prentice Avenue and a jetty extension of Prentice Avenue to the east, the Wisconsin Central Limited (WCL) railroad to the south, the Ellis Avenue and the marina extension of Ellis Avenue to the west, and Chequamegon Bay to the north. The impacted area of Kreher Park occupies approximately 13 acres.

The offshore area with impacted sediments is located in an inlet created by the Prentice Avenue jetty and marina extensions previously described. For the most part, contaminated sediments are confined in the inlet bounded by the northern edge of the line between the Prentice Avenue jetty and the marina extension. Contaminated sediment levels quickly decline beyond this boundary. The affected sediments consist of lake bottom sand and silts, and are overlain by a layer of wood chips, likely originating from former lumbering operations. The chips layer varies in thickness from 0 to seven feet, with an average thickness of nine inches. The entire area of impacted sediments encompasses approximately nine acres.

The Site contains four affected areas of concern (ACs), shown on Figure 6. These include two ACs on the Xcel Energy property (the Upper Bluff/Filled Ravine and Copper Falls Aquifer), the Kreher Park area, and the affected offshore sediments. The filled ravine is a former drainage feature that begins near the Xcel Energy administration building fronting on Lakeshore Drive, and deepens and widens to the north (see Figure 7). The mouth of the ravine opens to Kreher Park through the bluff face at the north end of the gravel storage yard. The maximum depth of fill in the ravine at the mouth is approximately 33 feet. The Copper Falls Aquifer is a confined, variably coarse to fine-grained sand (reworked glacial till) that underlies the entire Lakefront site (see Figure 5). The formation is overlain by the surficial Miller Creek Formation, which is a lacustrine clay to silt till unit. At the Xcel Energy property, the Miller Creek has a maximum thickness of about 35 feet; the thinnest portion of the unit is at the mouth of the former ravine, at approximately four feet. The Miller Creek Formation is overlain by fill at the lakefront (Kreher Park) and at the buried ravine. Based upon historic drilling logs at Kreher Park, the Miller Creek thickens to the north of the mouth of the buried ravine, and continues to thicken offshore.

2.1.2 Site History

Historically, Chequamegon Bay has been utilized as a vital transportation route for the shipment of various materials to and from Ashland including iron ore, lumber, pulp and coal. During the late 19th and early 20th centuries, Ashland was one of the busiest ports on the Great Lakes. In recent times, the shipping industry through the bay has declined because of the decline in the mining and lumber industries in the region.

The Kreher Park area is reclaimed land of which the south boundary defined the original lake shoreline. Beginning in the mid to late 1800's, this area was filled with a variety of materials including slab wood, concrete, demolition debris, municipal and industrial wastes and earthen fill that created the land now occupied by the park. The filled area was used for lumbering and sawmill activities by a number of lumber companies, the largest and longest tenured of which was the John Schroeder Lumber Company ("Schroeder Lumber"). Schroeder Lumber occupied the site from 1901 until 1939. Ashland County then took title to the property in 1940.

Schroeder Lumber's operations were extensive. Schroeder Lumber's "articles of incorporation" stated that one of the company's business purposes was to "...manufacture and deal in preservative chemicals, to own and operate wood preservation plants and plants for the manufacture and stillization of wood-byproducts, to explore and develop lands for gas, minerals, ores and oils, and to collect, work, use, and treat any timber and all forest and other vegetable products." Schroeder Lumber's Ashland plant was the company's <u>only</u> wood processing facility where it operated a sawmill, lath mill and planing mill. Schroeder Lumber's Ashland Sawmill/Wood Processing facility was described as "one of the largest and best equipped mills in the greater northwest." (Bell, 1998). Details of the Schroeder Lumber operation including the physical location of facility appurtenances were obtained from interviews and depositions of eyewitnesses, review of historic documents, as well as Sanborn Fire Insurance (Sanborn) maps. This information indicates that an above-ground structure or structures used for creosote/coal tar dipping or treatment of railroad ties, telephone poles and the like was located in the west-central area of the present Kreher Park area. Additionally, oil houses (the functions of which have not yet been definitively identified) were located in the east central part of Kreher Park as shown on the historic Sanborn Maps.

Following Schroeder Lumber's tenure, Ashland County transferred title to the City of Ashland in 1942, which has owned the site since. During the 1940's and 50's, the City operated a waste disposal facility (landfill) in the present northwest portion of the park area. Beginning in 1951, the WWTP was constructed, and operated as the City's sewage treatment facility until 1989. During the mid-1980's, the marina extension of Ellis Avenue was completed, which created more usable land to permit establishment of a marina with full service boat slips, fuel and dock facilities and a ship store. In 1989 during exploratory work to expand the WWTP into the Kreher Park area, soil and groundwater contaminated with creosote/coal tar compounds were encountered. The City notified the Wisconsin Department of Natural Resources (WDNR), and subsequently closed the WWTP, relocating the current facility a few miles away to the northeast. In 1994, the WDNR authorized Short Elliot Hendrickson, Inc. (SEH) to initiate an investigation and evaluation of the area to characterize the extent of contamination at the site.

On the upper bluff, a former Manufactured Gas Plant (MGP) was located at the Xcel Energy property. The former MGP building has been incorporated into the main service facility, a block long "U" shaped building on St. Claire Street. The former MGP building comprises the eastern one-third of the service facility. The former MGP operated predominantly as a manufacturer of water gas and carbureted water gas between 1885 and 1947. Fairly extensive records, including the Brown's Directories of Gas Statistics and company operating reports and ledgers provided a basis for calculation of total gas and residual tar produced by the plant during the period it operated.

Coal tars were produced as a normal co-product of gas manufacturing. Only three years of data is available concerning the disposition of the coal tar co-product material. However, operating records from those years indicate that, in addition to being burned on site for energy recovery, much of the tar was sold as a useful product consistent with the national practice at the time.

During the early tenure of the MGP, the previously described buried ravine was not filled-in and trended north across the site from Lake Shore Drive to the bluff overlooking the bay. Historic Sanborn maps indicate the ravine was filled from south to north. By 1909, the entire ravine was filled.

Xcel Energy has investigated its property through a series of investigations beginning in 1995. These investigations confirm that the ravine fill is a low permeability, mixed fill consisting of clays, cinders and rubble, with saturated conditions at depths varying from five feet below the service building to about 20 feet at the north end of the gravel storage area. These investigations have also identified subsurface contamination resulting from historic MGP operations. Contamination exists as dissolved phase coal tar constituents in groundwater and as "pools" of DNAPL of coal tar by-product. Coal tar has been encountered at the base of the ravine and in the underlying Copper Falls Aquifer. In the ravine, coal tar varying from one to two feet in thickness is present at the base of the ravine from south of the service facility north to the area of St. Claire Street. In the upper Copper Falls Aquifer, coal tar has been encountered from south of the service facility north to the gravel parking and storage yard area north of St. Claire Street. It has also been measured in a piezometer installed on the Our Lady of the Lake church property west of Third Avenue East. Xcel Energy installed an interim action coal tar recovery system on its property to remove coal tar from the Copper Falls Aquifer during the summer/fall of 2000; the system became fully operational in January 2001. The coal tar recovery system consists of three extraction wells, an oil/water separator, and an on-site groundwater treatment system. Groundwater samples have been collected quarterly since the coal tar recovery system began operating, and results have been presented in progress reports. More than 5,000 gallons of coal tar has been removed, and nearly 750,000 gallons of contaminated groundwater has been treated between January 2001 and July 2003.

A distinct DNAPL pool varying in thickness up to five feet was present in the area around the "seep"[2] located in Kreher Park just north of the mouth of the former ravine. A clay tile that discharged to the "seep" area (located north of the mouth of the buried ravine at the railroad was encountered at the base of the backfilled ravine during investigations completed between September and November 2001. Coal tar encountered in the shallow southern portion of the ravine near the former MGP building provides a source for contaminated groundwater flow, north through the former ravine into Kreher Park. However, the contaminant levels measured in wells screened in the ravine north of St. Claire Street are significantly lower than wells screened in the ravine south of St. Claire Street (where free-product coal tar is present), or at the seep. The buried clay tile likely behaved as a conduit for the migration of coal tar as well as

[2] The seep area had been the location of intermittent groundwater discharge containing a sheen and occasional odor of coal tar, until NSP performed the seep interim removal action in 2002.

contaminated groundwater. However, a significant portion of the clay tile was destroyed during the 2001 investigation activities.

Xcel Energy performed a second interim remedial response during May 2002 to eliminate the seep area. Activities completed included the excavation of contaminated soil in the seep area, the placement of a low permeability cap over the seep area, and the installation of a groundwater extraction well installed at the base of the buried ravine. Contaminated groundwater collected near the mouth of the ravine via a fourth extraction well is conveyed to the on-site treatment system described above. (Figure 3 shows the location of the extraction wells, EW-1 through EW-4, and the treatment building located on the Xcel Energy property.)

2.1.3 Regulatory Framework / Project History

An initial evaluation by the WDNR in 1994 prompted the Agency to issue a responsible party notice letter to Xcel Energy in March 1995.[3] Xcel Energy then authorized Dames & Moore (D&M), now URS, to begin a series of investigations at its property that year. At approximately the same time, the WDNR authorized SEH to investigate the Kreher Park area of the Site.

D&M/URS performed several investigations during the next several years to characterize the extent of contamination in the buried ravine and Copper Falls Aquifer. The interim actions performed on the Copper Falls Aquifer and seep discharge area at Kreher Park (described above) resulted from these investigations. In addition, ongoing quarterly monitoring of groundwater in the Copper Falls Aquifer is performed as part of the routine operation, maintenance and monitoring on the coal tar removal system.

Under contract to the WDNR, SEH performed a series of investigations at the Kreher Park area of the Site and the bay sediments during this same period. Part of this work included both human health and ecological risk assessments, the latter confined to the bay sediments.[4] Both

[3] The City of Ashland and Wisconsin Central Limited Railroad (n.k.a. Canadian National) also received responsible party letters. The City received letters dated August 21, 1991 and November 20, 1997. Wisconsin Central Limited received a letter dated November 20, 1997.

[4] SEH performed two Ecological Risk Assessments, one in 1998 and again in 2001. The second resulted from a review of the first document by USEPA. USEPA concluded that the first document was insufficient to establish effects concentrations because of a lack of representative data points. These comments mirrored URS's earlier review of the SEH 1998 report.

the URS and SEH investigations have been performed in accordance with chs. NR 700, et seq. Wisconsin Administrative Code (WAC).

During 1998, Xcel Energy signed a Spill Response Agreement with WDNR to complete remedial action options reports (feasibility reports) on both its property and the Kreher Park/bay sediments areas. The later two ACs were evaluated as an alternative feasibility analysis to an SEH study performed for the WDNR, and issued in a December 1998 report. D&M/URS prepared two separate reports, one for the two ACs on the Xcel Energy property, and the other for the Kreher Park/bay sediments. Both reports were issued in March 1999. Xcel Energy and WDNR subsequently began a process of technical discussions designed to result in a remedial action decision for the four ACs. In the Spring of 1999, a private citizen petitioned USEPA to evaluate and score the Site for possible listing on the National Priorities List (NPL), or "Superfund" list. Because of this petition, the WDNR and Xcel Energy held in abeyance further efforts toward the remedial action decision-making process.

The Site was proposed for listing on the NPL in December 2000. During early 2002, USEPA and WDNR entered into a Cooperative Agreement to fund an evaluation of analytical data that had been developed to date and to prepare a plan to complete all remedial investigation activities in accordance with National Oil and Hazardous Substances Pollution Contingency Plan (NCP) protocol. WDNR authorized SEH to perform these tasks. In 2002, the Site was also identified for inclusion in the Contaminated Sediment Technical Advisory Group (CSTAG) program from USEPA headquarters in Washington, D.C.[5] During July 2002, representatives of CSTAG which included members from nine USEPA regions, met in Ashland to review presentations from invited stakeholders and to formulate recommendations for further study. CSTAG submitted a series of recommendations at approximately the same time the site was formally listed on the NPL (September, 2002). Xcel Energy representatives met with representatives of USEPA and WDNR in October 2002 to request consideration of the CSTAG recommendations as part of the RI activities being formulated by WDNR at that time, and to suggest that certain data gathering and assessment activities planned by Xcel Energy be incorporated into the pending work.

A series of technical meetings were held during the fall and winter of 2002/2003 among Xcel Energy, WDNR and USEPA to discuss these RI activities. Because of seasonal weather access

[5] See OSWER Directive 9285.6-08, *Principles for Managing Contaminated Sediment Risks at Hazardous Waste Sites.* (Feb. 12, 2002).

constraints and the need to meet the winter deadline for "ice-out," the first of these RI activities included supplementary sediment sampling on the bay sediments for further physical characterization of these sediments. In accordance with USEPA approval, WDNR implemented an investigation of the sediments during March 2003 to allow access supported by winter ice. Further RI work, however, was not implemented. At this same time, Xcel Energy began discussions with USEPA and WDNR regarding work Xcel Energy was prepared to implement.

Following discussions held in May and June 2003, on August 8, 2003 USEPA sent Xcel Energy a General Notice letter with a proposed AOC (with attached Statement of Work (SOW)) for performance of the RI/FS at the Site. On August 22, 2003 Xcel Energy submitted a good faith offer/letter of intent, along with Revision 00 of the RI/FS Work Plan, developed as part of the proposed AOC/SOW.

A negotiation meeting was held among USEPA, WDNR and Xcel Energy representatives on September 18, 2003 to discuss the proposed AOC/SOW. This meeting triggered a final round of revisions on the AOC/SOW that resulted in a conference call among the parties on October 30, 2003 to finalize remaining issues. The AOC was then formally executed on November 14, 2003.

At the time of the AOC negotiations, USEPA conditionally approved the portion of the Revision 00 work plan and associated Quality Assurance Project Plan (QAPP) addressing the subsurface investigation of the upper bluff/filled ravine and Copper Falls Aquifer ACs. Pursuant to this conditional approval, Xcel Energy installed four piezometers on its property and the Our Lady of the Lake property in December, 2003. Groundwater samples were collected from these wells as part of the ongoing monitoring for the interim tar removal system.

SEH submitted an alternative Remedial Investigation Work Plan on October 31, 2003. The AOC specified that Xcel Energy consider investigation activities proposed in the SEH plan, and incorporate those activities as appropriate in its Revision 01 work plan. However, prior to preparing this document, the AOC required that Xcel Energy submit a Technical Letter Report (TLR) comparing the two work plans. This TLR was to serve as the basis for a technical scoping meeting held among the agencies and Xcel Energy, which would culminate in a USEPA meeting summary, followed by the Revision 01 work plan. The TLR was submitted on December 12, 2003; the technical scoping meeting was held on January 8, 2004. Xcel Energy received the meeting summary on January 19, 2004. This Revision 01 work plan meets the submittal requirements as specified in the AOC.

2.1.4 Summary of Previous Investigations

WDNR's contractor, SEH, produced several documents from 1995 through 1998. SEH concluded in its 1998 remedial action options report (RAOR) that the primary source of contamination at the property was caused by releases from the historic MGP.[6] This was based in part, on the following:

- The identification of MGP appurtenances such as former gas holders and storage tanks shown on historic Sanborn maps;
- The physiographic location of the MGP in relation to Kreher Park (on an up gradient bluff overlooking the park area);
- The identification of a former ravine that transected the MGP site and opened onto the park area during part of its operating life that may have been a pathway for contaminants; and

[6] The SEH report provided the following:

> The variations in concentration and distribution of individual PAHs or VOCs are possibly attributable to different waste sources (e.g., MGP wastes vs. wood treatment waste), historic changes in production processes or waste disposal practices (e.g., MGP switching from coal carbonization to carbureted water gas process), or geochemical or biodegradation processes. . . . A potential additional source of contamination on the Ashland Lakefront Property is the material comprising the "Coal Tar Dump" depicted on a 1953 (sic) site drawing prepared by Greeley & Hanson. Whether the material located in this area is in fact coal tar, wood treatment residuals, or some combination of these wastes has not been determined. The potential also exists that wood treatment may have historically occurred at other locations on the Ashland Lakefront property. However, conclusive evidence of this has not been found to date.

See, Remedial Action Options Feasibility Study – Ashland Lakefront Property and Contaminated Sediments, SEH, December 1998) at pg. 17.

See also, Comprehensive Environmental Investigation Report, SEH (May 1997) at Ppgs. 19, 30-31.

- The identification of a 2-inch diameter pipe on the former MGP property on Greeley and Hansen engineering drawings for the 1951 construction of the WWTP. This pipe, labeled by Greeley and Hansen as *"2" Tar to For. Dump*,[7] was shown in cross-section and plan view crossing beneath St. Claire Street, and appeared to align with and lead to the location of an area labeled as "waste tar dump" shown on the Greeley and Hansen drawings north of the former seep area at Kreher Park.

As previously described, D&M/URS investigated the Xcel Energy property to characterize the extent of contamination beginning in 1995. Additionally, historical research on the operation of the MGP was also performed. The findings of this work were described in the Supplemental Investigation and Remediation Action Options Report for the Xcel Energy property (March 1999). The salient information from this report as well as earlier studies is as follows:

- Releases of coal tar product occurred during the lifetime of the MGP. DNAPL was found in the form of coal tar contaminated soils at the base of the former ravine below the water table. The DNAPL is restricted to the area south of St. Clair Street below the current Xcel Energy service garage. DNAPL had not been found north of St. Clair Street in this geologic unit in the former ravine. However, DNAPL was present in the fill aquifer at the former surface water seep, north of where the ravine opens onto Kreher Park.

- The MGP operated primarily as a manufacturer of water gas or associated derivatives from about 1885 to 1947. This process resulted in a lack of nitrogen containing compounds (e.g., cyanides, phenols) found at other gas plant sites that used coal carbonization methods;

- The product consists primarily of coal tar residue. Other typical MGP by-products (purifier box waste, clinker waste, etc.) are not predominant. This is consistent with the MGP process discussed above;

[7] This dump area has been the focus of NSP's efforts to locate a reported creosote dipping structure during Schroeder Lumber's tenure. Note also that these historic engineering drawings developed for construction of the former WWTP show a buried culvert connecting the "Coal Tar Dump Area" to a swale which led to the bay. This culvert may have been installed as an attempt to drain this area to the bay, which was a residual of Schroeder Lumber's wood treatment operations.

- DNAPL is found in a confined aquifer below a clay unit (the Miller Creek formation) directly beneath the former MGP. This confined aquifer (the Copper Falls formation), does not have a hydraulic connection with the fill aquifer at Kreher Park;

- Groundwater discharges from the mouth of the former ravine onto Kreher Park; coal tar contamination is present in this groundwater, but at levels several orders of magnitude below what is measured either at up gradient wells south of St. Clair St., or at down gradient wells at Kreher Park;

- The ravine was backfilled with uncontrolled fill (clay, cinders, and brick) by 1909; and

- The alleged 2" Tar Pipe, as labeled by Greeley and Hansen post-hoc, was investigated during the fall of 1998. The Greeley and Hanson drawings, as well as Xcel Energy historical drawings, identified an underground pipe that began and ended on the Lake Superior District Power (LSDP – a predecessor to Xcel Energy) property. No indication of it is shown on any drawings that depict conditions at Kreher Park. Additionally, the 1998 field investigation found an approximate 2" metal pipe along with two additional pipes that were known to transport propane below St. Claire Street following closure of the MGP. A section of this pipe was analyzed by a metallurgical firm, Crane Engineering and Forensic Science (Crane) in Minneapolis, Minnesota. Crane concluded that the pipe was manufactured between 1920 and 1940 and likely carried water, steam or compressed air. There was no physical indication or residue of hydrocarbon to suggest the pipe historically carried hydrocarbons; (i.e. coal tars or coal tar emulsions). Appendix C of the D&M/URS March 1999 Remedial Action Options Report for the Ashland Lakefront Site includes the Crane report.

Subsequent investigations of the buried ravine by URS in 2001 identified the former clay tile that was the likely source of the seep discharge. This clay tile was found at the base of the ravine from the seep along the entire ravine axis, leading to the area of the former MGP. The crushing/removal of short segments of the tile during the 2001 investigations, the installation of the extraction well at the base of the ravine on the north side of the gravel storage yard (at the former ravine mouth) in May 2002, and the installation of the low permeability cap at the seep has essentially eliminated further seep discharge to the surface.

As described above, Xcel Energy and the WDNR have made differing conclusions as a result of their respective investigations at the Site with regard to the sources of contamination. Eyewitnesses have provided deposition testimony on wood treatment operations that the WDNR has questioned. Regardless of these differences, there is little difference of opinion on the degree and extent of contamination in the four ACs. Further information on the nature and extent of these contaminants is discussed in Section 3.0.

The following is a list of reports and related documents performed by SEH and others at the Kreher Park and Bay Sediments site:

- *Environmental Assessment Report - City of Ashland WWTP Site* (Northern Environmental Technologies (NET), August 1989);
- *Report of Test Pits at the Ashland WWTP* (NET, September 1991);
- *Remedial Investigation Interim Report - Ashland Lakefront Property* (SEH, July 1994);
- *Existing Conditions Report - Ashland Lakefront Property* (SEH, February 1995);
- *Draft Remediation Action Options Feasibility Study - Ashland Lakefront Property* (SEH, February 1996);
- *Sediment Investigation Work Plan – Ashland Lakefront Property* (SEH, February 1996);
- *Sediment Investigation Report - Ashland Lakefront Property* (SEH, July 1996);
- *Comprehensive Environmental Investigation Report - Ashland Lakefront Property* (SEH, May 1997);
- *Supplemental Investigation Report - Ashland Lakefront Property* (SEH, March 1998);
- *Human Health Risk Assessment Exposure Assumptions* (SEH, March 1998);
- *Ecological Risk Assessment: Problem Formulation* (SEH, April 1998);

- *Baseline Human Health Risk Assessment - Ashland Lakefront Property* (SEH, June 1998);
- *Ecological Risk Assessment - Ashland Lakefront Property Contaminated Sediments* (SEH, October 1998);
- *Remediation Action Options Feasibility Study - Ashland Lakefront Property and Contaminated Sediments* (SEH, December 1998);
- *Seep Investigation Work Plan* (SEH, February 2001);
- *Pipe Source Investigation & Fingerprint Sampling – DNR work plan and contracts* (SEH, May 2001);
- *Investigation, Interim Remedial Action Options & Design Report* (SEH, October 2001);
- *Phase I Environmental Site Assessment* (Mid-States Associates – MSA, October 2001);
- *Final Phase II ESA Work Plan* (MSA – December 2001);
- *Environmental Forensic Investigation of Subsurface Pipes containing tar residues near a former MGP in Ashland, WI* (Battelle, January 2002);
- *Ecological Risk Assessment Supplement* (SEH, February 2002);
- *Phase II Environmental Site Assessment* (MSA, June 2002);
- *Quality Assurance Project Plan (QAPP) Task Specific – OU #4 Winter 2003, Sediment Sampling RI/FS* (SEH, February 2003); and
- *Remedial Investigation Work Plan – Ashland/NSP Lakefront Site* (SEH, October 2003).

D&M/URS, the Gas Technology Institute and others have developed documents that include review comments on selected SEH reports, as well as documentation for Xcel Energy concerning the historic MGP site. The following is a list of key documents, submitted to the WDNR concerning the Site:

- *Summary of field work conducted 12/94 at the NSP facility* (Cedar Corporation, January 1995);
- *Final Report - Ashland Lakefront/NSP Project* (D&M, March, 1995);
- *Proposed Work Plan for Remedial Action Plan* (D&M, March 1995);
- *Site Investigation Report and Remedial Action Plan - Northern States Power* (D&M, August, 1995);
- *Alternative Containment Design* (D&M, August 1995);
- *Design Report, Bidding Documents, Plans and Specifications for Interim Remedial Action - Northern States Power* (D&M, August, 1995);
- *Supplemental Site Investigation Work Plan and Schedule* (D&M, April 1996);
- *SEH Draft Remediation Action Options Feasibility Study - Review Comments for Northern States Power Company* (D&M, May, 1996);
- *Supplemental Groundwater Investigation Final Report for Northern States Power Company* (D&M, August, 1996);
- *Proposed Work Plan – Deep Aquifer Investigation – Copper Falls Formation* (D&M September, 1996;
- *Copper Falls Aquifer Groundwater Investigation for NSP* (D&M, February, 1997);
- *Comments on Proposed Ecological Risk Assessment* (D&M, July 1997);

- *Aquifer Performance Test and Groundwater Monitoring Results for Northern States Power* (D&M, October, 1997);
- *Exploration Trench Activities and Findings (2-inch pipe report);* (D&M March 1998);
- *Aquifer Remedial Action Plan - Lower Copper Falls Formation for NSP* (D&M, April, 1998);
- *Comments to SEH Human Health Risk Assessment Exposure Assumptions* (D&M, April 1998);
- *Comments to SEH Supplemental Investigation Report* (D&M, April 1998);
- *Fencing Plan* (Dames & Moore, July 1998);
- *Supplemental Site Investigation Work Plan* (D&M, July 1998);
- *Examination of excavated pipe sample* (Crane Engineering, October 1998);
- *Comments to SEH Ecological Risk Assessment* (D&M, December, 1998);
- *Ecological Risk Assessment for the Ashland Lakefront Property* (D&M, March 1999);
- *Supplemental Facility Site Investigation and Remedial Action Options Evaluation Report prepared for Northern States Power, Ashland, Wisconsin* (D&M, March, 1999);
- *Remedial Action Options Feasibility Study – Final Report for the Ashland Lakefront Site, prepared for Northern States Power, Ashland, Wisconsin for NSP* (D&M, March, 1999);
- *PCB Testing Work Plan* (D&M, April 1999);
- *Supplemental PCB Site Investigation Results for the NSP Facility* (D&M, July 1999);

- *Supplemental Site Investigation Work Plan for the NSP Facility* (D&M, July 1999);
- *1999 Supplemental Site Investigation for the Northern States Power Facility, Ashland, Wisconsin* (D&M, October, 1999);
- *Fingerprint Analysis of Free Product Samples from MW-15 and MW-7* (Institute of Gas Technology (now Gas Technology Institute), November 1999;
- *Interim Design – Plans and Specifications for a Coal Tar Removal System at the NSP Facility* (D&M, March 2000);
- *Comparative Analysis of NAPL Residues from the NSP Ashland Former MGP and Ashland Lakefront Property (Kreher Park)* (IGT, March 2000);
- *Addendum to the IGT Report: Comparative Analysis of NAPL Residues from the NSP Ashland Former MGP and Ashland Lakefront Property (Kreher Park) – Comparative Analysis of Sediment Samples from the Chequamegon Bay near the Kreher Park Shoreline* (IGT, May 2000);
- *Interim Action Groundwater Monitoring Plan for the NSP Facility* (D&M, September 2000);
- *Interim Action O&M Report – Coal Tar Recovery System* (URS, February 2001);
- *Construction Documentation Report – Interim Response Coal Tar Recovery System, Xcel Energy Facility, 301 Lake Shore Drive, Ashland, Wisconsin, prepared for Xcel Energy* (URS, February 2001);
- *Progress Report #001 – Interim Response Coal Tar Recovery System, Xcel Energy Facility, 301 Lake Shore Drive, Ashland, Wisconsin, prepared for Xcel Energy* (URS, February 2001);
- *Second Addendum Comparative Analysis of Two Samples* (GTI, April 2001);

- *Third Addendum Comparative Analysis of 10 Sediment Samples from Chequamegon Bay* (GTI, May 2001);

- *Final Report – Sediment Sample Results, NSP/Ashland Lakefront, Ashland, Wisconsin, prepared for Xcel Energy* (URS, June, 2001);

- *URS Response to U.S. EPA Comments on the SEH's "Ashland Lakefront Property - Contaminated Sediments Ecological Risk Assessment"," and responses to TOSC comments to Dames & Moore's "Ecological Risk Assessment Ashland Lakefront Property" and to SEH's "Ashland Lakefront Property - Contaminated Sediments Ecological Risk Assessment."* (URS, June 2001);

- *Progress Report #002 – Interim Response Coal Tar Recovery System, Xcel Energy Facility, 301 Lake Shore Drive, Ashland, Wisconsin, prepared for Xcel Energy* (URS, July, 2001);

- *Revised Estimation of Tar (DNAPL) in Bay Sediments* (GTI, August 2001);

- *Work Plan to Perform Pipe Investigation – Buried Ravine – Clay Pipe* (URS, August 2001);

- *Progress Report #003 – Interim Response Coal Tar Recovery System, Xcel Energy Facility, 301 Lake Shore Drive, Ashland, Wisconsin, prepared for Xcel Energy* (URS, October 2001);

- *Air Monitoring Results from Pipe Investigation Conducted September 2001* (URS, December 2001);

- *Progress Report #004 – Interim Response Coal Tar Recovery System, Xcel Energy Facility, 301 Lake Shore Drive, Ashland, Wisconsin, prepared for Xcel Energy* (URS, December 2001);

- *Fourth Addendum: Analysis of 11 Liquid Samples and One Soil Sample from the Ashland Lakefront Site* (GTI, January 2002);

- *Final Report – Clay Tile Investigation, NSP/Ashland Lakefront, Ashland, Wisconsin, prepared for Xcel Energy* (URS, February 2002);

- *Work Plan for Piezometer Installation* (URS, January 2002);

- *Progress Report #005 – Interim Response Coal Tar Recovery System, Xcel Energy Facility, 301 Lake Shore Drive, Ashland, Wisconsin, prepared for Xcel Energy* (URS, February 2002);

- *Contingency Plan for Interim Response Coal Tar Recovery System, Xcel Energy Facility, 301 Lake Shore Drive, Ashland, Wisconsin, prepared for Xcel Energy* (URS, March 2002);

- *Seep Area Interim Action Work Plan and Report* (URS, April 2002);

- *Comments on the SEH Ecological Risk Assessment Supplement* (URS, May 2002);

- *Former Gas Holder Work Plan – Additional Piezometer Installation* (URS, May 2002);

- *Progress Report #006 – Interim Response Coal Tar Recovery System, Xcel Energy Facility, 301 Lake Shore Drive, Ashland, Wisconsin, prepared for Xcel Energy* (URS, June 2002);

- *Final Report – Seep Interim Action Documentation Report, Ashland Lakefront Site, Ashland, Wisconsin, prepared for Xcel Energy* (URS, August 2002);

- *Progress Report #007 – Interim Response Coal Tar Recovery System, Xcel Energy Facility, 301 Lake Shore Drive, Ashland, Wisconsin, prepared for Xcel Energy* (URS, September 2002);

- *Quality Assurance Project Plan – Ashland Lakefront Project* (URS, December 2002);

- *AOC Work Plan #1 – Supplemental Site Investigation & Piezometer Installation* (URS, January 2003);

- *Progress Report #008 – Interim Response Coal Tar Recovery System, Xcel Energy Facility, 301 Lake Shore Drive, Ashland, Wisconsin, prepared for Xcel Energy* (URS, January 2003);

- *Quality Assurance Project Plan Addendum – OU-4 Winter Sediment Split Sample Collection* (URS, February 2003);

- *"Straw Man" Baseline Problem Formulation for Affected Bay Sediments, prepared for Xcel Energy* (URS, March 2003);

- *Progress Report #009 – Interim Response Coal Tar Recovery System, Xcel Energy Facility, 301 Lake Shore Drive, Ashland, Wisconsin, prepared for Xcel Energy* (URS, May 2003);

- *Progress Report #010 - Interim Response Coal Tar Recovery System, Xcel Energy Facility, 301 Lake Shore Drive, Ashland, Wisconsin, prepared for Xcel Energy* (URS, August 2003);

- *Progress Report #011 - Interim Response Coal Tar Recovery System, Xcel Energy Facility, 301 Lake Shore Drive, Ashland, Wisconsin, prepared for Xcel Energy* (URS, October 2003);

- *Technical Letter Report – Comparison of URS and SEH Work Plans* (NewFields, December 2003);

- *Ashland/NSP Lakefront Site – December 2003 Progress Report (No. 1)* (Xcel Energy, December 2003);

- *Ashland/NSP Lakefront Site – January 2004 Progress Report (No. 2)* (Xcel Energy, January 2004); and

- *Ashland/NSP Lakefront Site – February 2004 Progress Report (No. 3)* (Xcel Energy, February 2004).

2.2 SITE PHYSICAL AND ENVIRONMENTAL SETTING

2.2.1 Regional Geology and Hydrogeology

Ashland is located in the Lake Superior Lowland Province, a sub province within the Northern Highland Province. These lowlands consist of a low plains developed on Late Precambrian aged sedimentary bedrock overlain by unconsolidated glacial deposits. The lowlands rise several hundred feet above the present level of Lake Superior as gently sloping plains that were covered by glacial lakes ancestral to Lake Superior.

The upper most geologic unit (excluding the anthropomorphic fill soils and debris) is the Miller Creek Formation. The Miller Creek Formation is described as a silty clayey unit that is laterally continuous, ranging in thickness from several feet up to 50 feet in the Ashland area. The Miller Creek is underlain by the Copper Falls formation, which includes glacial till and glacial outwash sediments. The Copper Falls is underlain by Precambrian sandstones of the Oronto Group. The thickness of this unit is unknown, but it is likely underlain by Precambrian basalt. According to published geological maps (Skinner, 1974) the depth to bedrock at this site is between 150 and 200 feet. Bedrock was encountered at 192 feet during the latest exploration drilling program at the Xcel Energy property during December 2003 (Monitoring well MW-2C). Bedrock in the Ashland area consists of Precambrian sandstones. The dip on the bedrock-sediment surface is toward the southeast. This dip appears to be caused by a blind extension of the Douglas Thrust Fault interpreted to exist south of the City of Ashland.

Regional aquifers correspond to regional geologic units. The Copper Falls Formation is the principal regional aquifer in the Ashland area. However, Lake Superior is the potable water source for the municipal water supply for the City of Ashland. The regional direction of groundwater flow is north toward Lake Superior.

2.2.2 Site Physiography

2.2.2.1 Topography

As previously described, the Xcel Energy property is located on relatively flat lake terrace deposits above a bluff overlooking Chequamegon Bay. The elevation of the Xcel Energy property is approximately 640 feet MSL, and slopes gradually toward the bluff face. The bluff itself slopes abruptly to Kreher Park, which is a slightly sloping fill deposit. The railroad grade at the bluff face is elevated above the park area proper at an elevation of about 610 feet MSL. The park itself slopes from the base of the railroad grade at elevation 605 feet MSL to the lake level of ±601 feet MSL.

2.2.2.2 Storm Water/Surface Water Conditions

Storm water in the vicinity of the Site flows north toward Lake Superior. On the Xcel Energy property, the area occupied by the buildings and parking lots is relatively flat, at an elevation of approximately 640 feet above MSL. Drainage from the Xcel Energy property is to the north. To the northwest, the site slopes steeply to the WCL Railroad property, and then to Kreher Park, beyond which is Chequamegon Bay. The Kreher Park area consists of a flat terrace adjacent to the Chequamegon Bay shoreline. The surface elevation of the park varies approximately 10 feet, from 601 feet MSL, to about 610 feet MSL at the base of the bluff overlooking the park. The bluff rises abruptly to an elevation of about 640 feet MSL, which corresponds to the approximate elevation of the Xcel Energy property. The lake elevation fluctuates about two feet, from 601 to 603 feet MSL.

Information provided by the City of Ashland's Department of Public Works indicates that the City had a combined storm and sanitary sewerage system until the early to mid 1980's. The storm sewer system was separated from the sanitary system at that time to reduce flow to the former WWTP. Presently, storm water discharges directly to Chequamegon Bay through a series of outfalls. The City reported several outfalls are present at the bluff face at Kreher Park, which discharge to swales at the park, which in turn discharge to the Bay. The city is currently installing a storm system upgrade to redirect storm water flow away from the Site.

2.2.2.3 Site Geology and Hydrogeology

Geology in the vicinity of the Site includes three unconsolidated lithostratigraphic units. The Miller Creek Formation and the underlying Copper Falls Formation comprise two of these units. The third lithostratigraphic unit is the fill material used to backfill the former ravine beneath the Xcel Energy facility, and the fill material placed in the Kreher Park area. Fill material on both properties is underlain by fine-grained silts and clays of the Miller Creek Formation. These units are shown on the Geologic Cross-Section included as Figure 5.

The fill soils on both properties vary in thickness. The backfilled ravine dissects the Miller Creek Formation on the Xcel Energy property. The base of the ravine was encountered within approximately nine feet of the existing ground surface in the alley south of the vehicle maintenance building, and up to 15 feet in the parking area of the maintenance building south of St. Claire Street. The ravine width narrows, but deepens north of St. Claire Street; the base of the ravine, along its axis, was encountered at depths between 20 and 33 feet below the existing ground surface north of St. Claire Street. The ravine fill unit consists of silty clay fill material mixed with ash, cinders, slag, and fragments of bricks, concrete, glass, and wood. Beneath Kreher Park, the fill soils range from 0 to about 10 feet in thickness. This fill material consists of fragments of bricks, concrete, glass, and waste wood. Generally, the Kreher Park fill is more coarse-grained and contains large fragments, compared to the finer-grained materials in the buried ravine. (Municipal and industrial waste was also placed in the northwest portion of Kreher Park.)

The Miller Creek formation, which comprises the bluff located at the south end of Kreher Park, is the uppermost stratigraphic unit underlying the fill at Kreher Park and the sediments in Chequamegon Bay. The Miller Creek formation is a low plasticity silty clayey unit. As previously described, the depth of the Miller Creek below the Xcel Energy property is approximately 35 feet. Because the ravine deepens to the north, the separation between the base of the ravine at its mouth and the underlying Copper Falls Aquifer is only about four feet. From this location north toward the bay, the Miller Creek thickens to about 40 feet before extending below the bay.

The formation grades from a low plasticity silty clay (CL) to a non-plastic silt (ML) with depth. Thin discontinuous silty sand lenses are also present within this unit. Moving from a southerly direction from a point between the MW-9A and MW-4A well locations on the Xcel Energy property, the Miller Creek formation grades from a silty clay into a silt and silty sand unit at the base of the backfilled ravine. The higher plasticity portions of the Miller Creek Formation were likely removed by erosion when the ravine was created.

The Copper Falls Formation underlies the Miller Creek Formation, and consists of granular, cohesionless material deposited by glacial melt waters. The depth of the Copper Falls was not fully penetrated during any of the investigations performed. The maximum depth of the Copper Falls encountered in any of the investigation borings was approximately 160 feet south of St. Claire Street at the MW-9C location. To the south, beneath the Xcel Energy facility, the Copper Falls consists of silty sands with discontinuous lenses of silty clay and silt. To the north, beneath Kreher Park, the Copper Falls formation consists of outwash sediments (i.e., clean sands with occasional gravel intervals).

The ravine fill and Kreher Park fill material, Miller Creek, and Copper Falls lithostratigraphic units also behave as hydrogeologic units. The fill materials overlying the Miller Creek Formation at Kreher Park and in the ravine contain a saturated water table condition. These fill units behave as perched aquifers separated from the underlying Copper Falls aquifer by the Miller Creek aquitard. Typical of perched conditions, vertical gradients between the ravine aquifer and the shallowest piezometers indicate a wide range of downward flow conditions. The smallest downward gradient was observed at the MW-5/-5A interval, and strong downward gradients were observed at the TW-13/MW-13A interval.

A groundwater mound is present in the ravine fill south of St. Claire Street. North of St. Claire Street, the water table in the ravine is characterized by a fairly steep gradient that flows through the mouth of the former ravine into Kreher Park. Groundwater flow within the perched aquifer within the northern portion of the ravine is toward the northwest, which coincides with the ravine axis. The low permeability fill soils in the ravine are in (10^{-6} to 10^{-8} cm/sec) contrast to the wood waste/demolition waste materials at Kreher Park. The water table in the fill at the park is characterized by high permeabilities (0.1 to 10^{-5} cm/sec), but with a very flat gradient, consistent with similar filled in lake bottom lands.

At Kreher Park, the groundwater "seep" formally located north of the mouth of the backfilled ravine discharged water to the surface with variable flow, depending on rain events and seasonal conditions. The elevation of the seep was over five feet above the water table levels measured in MW-7, which is located immediately adjacent to the seep. This indicated that the seep was likely created by water discharging from a buried pipe. As described above, the buried pipe was located and the seep area remediated as part of the 2002 interim action response.

The Miller Creek Formation behaves as an aquitard separating the overlying perched fill aquifers from the underlying Copper Falls aquifer. The thickness of the Miller Creek varies, but as described above thickens north of the Xcel Energy property from Kreher Park toward the bay. South of St. Claire Street., the Miller Creek formation becomes cohesionless, with a greater abundance of coarse grained soils. This allows the Copper Falls to become unconfined south of the alley located between St. Claire Street and Lakeshore Drive. In the vicinity of the former MGP and Kreher Park, the Copper Falls aquifer is confined. Typical of a confining unit, strong to moderate downward vertical gradients were detected within the Miller Creek aquitard. Vertical gradients within the Copper Falls aquifer indicate strong upward flow conditions. Strong upward vertical gradients have been observed at the MW-5B/-5C and MW-13A/-13B well nests on the Xcel Energy property. The vertical gradient measured at the MW-2 (NET) and MW-7 wells nest in Kreher Park also indicate that the vertical gradient in the underlying Copper Falls aquifer is strongly upward at these locations at the Park. The horizontal direction of groundwater flow in the Copper Falls Aquifer is toward the northwest.

2.3 AREAS OF CONCERN AND CONTAMINANT CHARACTERIZATION

2.3.1 Upper Bluff / Filled Ravine

The lateral extent of soil and groundwater contamination in the backfilled ravine has been characterized from borings advanced during previous phases of investigation, aerial photographs, and other historical information. Base maps showing the approximate ravine contours were created, and cross sections were also developed, which indicate the fill types and groundwater table elevations in the ravine. Isopach contours showing the thickness of the ravine fill, groundwater contours, and the lateral extent of groundwater contamination is shown on Figure 7.

Investigation results indicate that the former ravine dissects the fine grained low permeability Miller Creek formation. This unit is present in the sidewalls and at the base of the backfilled ravine and behaves as a confining unit for the underlying Copper Falls aquifer. The ravine fill unit consists of silty clay fill material mixed with ash, cinders, slag and fragments of bricks, concrete, glass and wood. The volume of the fill in the former ravine is estimated at 29,400 cubic yards.

The highest levels of soil contamination were detected within several feet of the surface in the vicinity of the former MGP located south of St. Claire Street. Site investigation results indicate that soil contamination is limited to the former ravine. The fine grained low permeability Miller Creek formation restricts the vertical and lateral migration of contaminants. The concentrations of contaminants decline with depth at several sample locations. Low levels of soil contamination were detected in soil samples collected around the perimeter of the former ravine which indicates that the concentration of contaminants also decline laterally with distance from the former MGP. Regardless, residual contaminant levels (RCLs) listed in ch. NR 720, WAC, for arsenic and coal tar constituents (benzene, toluene, xylene, acenaphthene, acenaphthylene, benzo(a)anthracene, benzo(a)pyrene, benzo(k)fluoranthene, fluoranthene, chrysene, indeno(1,2,3-cd)pyrene, 2-methylnaphthalene, naphthalene, and phenanthrene) were exceeded in soil samples collected from the Xcel Energy property.

Groundwater samples collected from shallow wells screened in the shallow aquifer on the Xcel Energy property detected coal tar constituents (benzene, toluene, naphthalene, trimethylbenzene (total), and xylene (total), anthracene, benzo(a)pyrene, benzo(k)fluoranthene, chrysene, fluoranthene, fluorene, naphthalene, and pyrene) above groundwater quality standards. Groundwater monitoring results for samples collected from wells screened in and around the backfilled ravine indicates that groundwater contamination in the shallow aquifer is limited to the former ravine. The highest concentrations of coal tar constituents were detected in samples collected from wells MW-4, MW-9, TW-13, MW-14, and MW-15 located within the groundwater mound south of St. Claire Street. Groundwater samples collected from well MW-5 indicate that groundwater contamination is also present within the backfilled ravine north of St. Claire Street. Samples collected from wells MW-1 and MW-2 indicate that groundwater contamination is limited to the base of the ravine in this area. Additionally, samples collected from perimeter wells MW-8, MW-10, and MW-11 screened in the Miller Creek Formation outside of the former ravine, and MW-6 screened at the head of the ravine south of the highest contaminant levels, also indicate that groundwater contamination is limited to the former ravine.

DNAPL has historically been encountered in wells MW-9, TW-13, and MW-15 screened in the backfilled ravine located in the vicinity of the former MGP. Several feet of DNAPL were measured in these wells after they had been installed. However, the thickness of DNAPL in these wells has declined since the interim response coal tar recovery system became operational. (Since the coal tar recovery system began operating, DNAPL thickness has been measured in site monitoring wells quarterly concurrent with the collection of groundwater samples; DNAPL is then bailed from each well if encountered, and discharged to the on-site remediation system.) First measured during June 2002, and then quarterly thereafter again during March 2003, DNAPL has been measured in MW-2R, located in the gravel storage area north of St. Claire Street.[8]

2.3.2 Copper Falls Aquifer

The Miller Creek grades into a silt and silty sand unit at the base of the former ravine south from an area between wells MW-4 and MW-9. The lithologic change in the Miller Creek at this area of the Xcel Energy property likely allowed the vertical (downward) migration of coal tars into the underlying Copper Falls aquifer. Approximately 50 feat east of MW-4 along the axis of the alley is well MW-15. This well is located in the footprint of a former gas holder, which was a likely source of coal tar to the Copper Falls. The depth of fill at MW-15 is more than 15 feet, which is east of the former ravine. (The maximum depth of fill to the west of this location along the ravine axis is about nine feet.) This 15 foot depth at MW-15 may correspond to the depth of the former holder's foundation excavation. To the north of this area the fine grained low permeability Miller Creek restricts the vertical migration of contamination, especially toward the bay where the Miller Creek thickens. Groundwater monitoring results detected elevated concentrations of coal tar constituents in samples collected from wells screened within the Copper Falls aquifer, as well as confirmed the presence of DNAPLs. (Because all soil within the Copper Falls is below the saturated zone, all contamination within the aquifer is considered groundwater contamination.) Groundwater elevation contours, the lateral extent of DNAPL, and the lateral extent of groundwater contamination in the upper Copper Falls Aquifer is shown on Figure 8. The vertical extent of groundwater contamination in the Copper Falls Aquifer is shown on Figure 5.

The highest concentrations of coal tar constituents were detected in samples collected from wells MW-2AR, MW-2B(NET), MW-4A, MW-5B, MW-7A, MW-13A, and MW-13B. The strong upward gradients observed in the confined Copper Falls aquifer has resulted in a plume in the

[8] MW-2R is a replacement well for MW-2, destroyed during investigation of the clay tile during Fall 2001. Coal tar had not been previously measured in well MW-2. These recent DNAPL measurements were potentially caused by the increase in permeability conditions of the ravine fill during excavation and backfill of the exploratory trenches advanced for this clay tile investigation. The source of this coal tar is likely that material identified south of St. Claire St.

Copper Falls that is deep near the source area, and laterally extensive down gradient from the source area. The upward gradients in the Copper Falls have "forced" these contaminants upward with the general northward flow of groundwater in this aquifer. Consequently, a mushroom shaped plume is present in the Copper Falls below the Xcel Energy property. Analytical data collected at various depths identified a deep column of contamination in the suspected area of the release, extending into the lower Copper Falls to an approximate depth of 120 feet below ground surface at the MW-9/MW-9A location. Although contaminants have also migrated laterally in the down gradient direction of groundwater flow, samples collected from wells screened in the lower Copper Falls aquifer indicate that contaminant concentrations decline with distance from the source area. (The concentrations of coal tar constituents have historically been detected at lower concentrations in samples collected from wells MW-2A(NET), MW-4B, MW-5C, MW-9A, MW-9B, MW-9C, MW-13C and MW-13D screened deeper in the Copper Falls Aquifer.) Contaminant levels appear to decline laterally away from the site. Elevated levels have been measured in deep wells at Kreher Park; however, no DNAPL has been measured beyond the upper bluff area in this aquifer. Additionally, two artesian wells east and northwest of Kreher Park have yielded no contaminants.

DNAPL was also encountered in wells EW-1, EW-2, EW-3, MW-2A/MW-2AR, MW-13A and MW-13B screened in the upper Copper Falls aquifer. Up to 20 feet of DNAPL were measured historically in well MW-13B, and several feet have been measured in the remaining wells. However, the thickness of DNAPL in these wells has declined since the interim response coal tar recovery system became operational. (As described above, since the recovery system began operating, DNAPL thickness has been measured in site monitoring wells quarterly concurrent with the collection of groundwater samples; DNAPL is bailed from each well if encountered, and discharged to the on-site remediation system.)

As previously discussed, Xcel Energy authorized the installation of monitoring wells at the Upper Bluff area on its property and the adjacent Our Lady of the Lake church property during December, 2003. These included monitoring wells MW-2C in the gravel storage yard north of St. Claire Street, wells MW-15A and -15B in the alley south of the service center, and MW-21B at the church property. Well MW-2C was installed intersecting the first layer of bedrock at 192 feet, with an effective screen between 197 and 190 feet. Wells MW-15A and -15B were nested wells in the upper Copper Falls at depths between 35 and 55 feet; well MW-21B was also nested with an existing well (MW-21A) in the upper Copper Falls at a depth of 50 feet. These wells were sampled following initial development along with the other Copper Falls monitoring wells included with the normal quarterly sample program. Although this initial round of data does not allow for any trend evaluation, experience at the site indicates that water quality data is a reasonable indicator of nearby DNAPLs. The initial water quality data for benzene and other associated VOCs showed elevated levels (in the hundreds of ppb range) for the samples collected from MW-15B and MW-21B. However, only trace levels of benzene (11µg/L) and other organic compounds were measured in the sample from MW-2C. Experience shows that several months following installation is often required before free-product is measured in wells installed in the Copper Falls. Consequently, continued monitoring on MW-2C will be required to confirm if contaminants have migrated to bedrock.

2.3.3 Kreher Park

Kreher Park is characterized by varying levels of contamination in soils and groundwater. Results of completed investigations indicate that the park area was covered by a 1 to 2 foot layer of clean surficial soil overlying the contaminated fill, which is comprised of soil mixed with slab wood and sawdust. The contamination consists primarily of volatile organic compounds (VOC) and polynuclear aromatic hydrocarbon (PAH) compounds. Metals were also detected in soil and groundwater samples, likely resulting from characteristics of historic fill as well as former landfill operations at the site. VOC and PAH impacted soils at Kreher Park approximates the area of shallow groundwater contamination. PAH soil contamination generally begins near the shallow groundwater surface, and extends to the top of the Miller Creek Formation. Emulsified NAPLs as well as an area of DNAPLs near the former seep[9] (and recently in one well north of the WWTP (TW-11)) have been measured in wells screened in Kreher Park fill soils. Groundwater elevation contours and the lateral extent of groundwater contamination at Kreher Park are shown on Figure 9. This data is predominantly based on analytical results developed by SEH.

2.3.4 Chequamegon Bay Inlet

The lateral and vertical extent of contamination in the Chequamegon Bay inlet adjacent to

[9] Contaminated soil in this area was removed, the intermittent groundwater discharge eliminated, and the area was capped with a low permeability geotextile and clean fill cover as part of the interim action completed by Xcel Energy in the spring of 2002.

Kreher Park has been identified during previous investigations. Contaminated near-shore sediments are located within the inlets created by the jetty extension of Prentice Avenue to the east, and the marina extension of Ellis Avenue to the west. Constituents of concern identified from previous investigations include VOCs and PAH compounds characteristic of a coal tar/creosote origin, similar to contaminants found at Kreher Park. However, the concentrations of contaminants in sediment are higher and more widespread than those found at the park. These levels are generally higher than the solubility limits for the subject compounds, indicating free-product is present.

A layer of wood chips overlies native sediment throughout the study area. The wood chip layer varies in thickness from 0 to 6-feet, averaging about nine inches. Native sediment underlying the wood chip layer consists of interbedded layers of sand, silty sand, silt and silty clay. The highest concentrations of VOCs and SVOCs were detected in sediment samples collected in the area south of a line between the WWTP and the marina and an area north of the WWTP. The highest levels are found at depths between 0 and 6 feet. Contaminants are present at deeper intervals, but the lateral extent of contamination at these deeper intervals is limited to isolated hot spot areas. The lateral extent of contamination consists of an area approximately 7 acres in size as shown on Figure 10.

During the winter of 2001, URS conducted a detailed study of the extent of sediment contamination to further refine work performed by SEH in 1996. The results of this study are included in URS report titled *Final Report – Sediment Sample Results, NSP/Ashland Lakefront, Ashland, Wisconsin, prepared for Xcel Energy* (June 1, 2001). Contaminant distribution maps for VOCs and SVOCs for two-foot intervals between the sediment surface and a depth of 10 feet below the surface developed from this study are presented in this report in Appendix A.

During March 2003, SEH collected additional data for physical characterization of the bay sediments. This data included dredged samples of the shallow sediments (0 to six inches) as well as additional background samples beyond the affected area. This data confirmed that the distribution of sediment contamination is similar to the distribution shown by the earlier investigations. Additionally, it showed that residual levels of heavier weight organic compounds (PAHs) at low levels (2 ppb and less) extend farther to the north than had previously been determined.

3.0 INITIAL EVALUATION

3.1 TYPES AND VOLUMES OF WASTE PRESENT

The type and volume of waste present at the Site are the result of historic activities on the Xcel Energy and Kreher Park properties. Waste includes fill material placed in the backfilled ravine on the Xcel Energy property, and fill material placed at Kreher Park. Additionally, contaminated soil, groundwater, and sediment resulting from the former MGP operations are present on the Xcel Energy property. Contaminated soil, groundwater and sediments resulting from MGP operations, historic waste disposal practices, and lumber treatment are present at Kreher Park. The primary contaminants of concern in all the ACs are VOCs and SVOCs, PAHs comprise the predominant subset of the SVOCs found at the site. Some metals are present, the source of which likely originated from former landfilling operations at Kreher Park and to a lesser extent, the former WWTP.

During the fall of 2003, a database of historic site analytical data was developed and placed on a geographic information system (GIS) platform using ARCGIS 1. Examples of the GIS are included in Appendix B. Information in the GIS will be referred to in subsequent sections.

A summary of the type and volume of waste is as follows.

- In the ravine, the estimated volume of fill material on the Xcel Energy property is approximately 29,400 cubic yards. The maximum estimated volume of DNAPL within the ravine, based on an assumed thickness of DNAPL of 1.5 feet, an area of 4,000 ft^2 and a porosity of 25 percent, is 11,220 gallons. (This volume is based on measurements of DNAPL restricted to wells south of St. Claire Street. Recent measurements of tar north of St. Claire Street have been measured in MW-2R. See Section 2.3.2 for further information.)

- At Kreher Park, the SEH March 1999 Remedial Action Options Report (RAOR) states that the contaminated park area covers approximately 10 acres, and that there is a one to two foot layer of clean fill overlying the contaminated fill. The depth of contamination ranges from one to fifteen feet. The impacted fill is estimated at 150,000 cubic yards, and the volume of clean fill overlying the contaminated soils is estimated at 45,000 cubic yards. A free-product plume was historically measured at the seep, at the location of monitoring well MW-7. This plume was a separate, distinct source, which likely originated from a combination of coal tar migration along the former clay tile identified at the base of the ravine, as well as rail offloading of fuel materials known to have occurred at this location. Much of this contaminated material and associated soils were removed (along with well MW-7) during the seep interim action in 2002.

Recent monitoring data (beginning June, 2003) indicates free-product at two other monitoring wells at Kreher Park, MW-3(NET) near the artesian well at Prentice Avenue, and TW-11, north of the WWTP along the shoreline. The product at MW-3(NET) has been measured at trace levels of floating light non-aqueous phase liquids (LNAPL); the product at TW-11, has been measured up to approximately one foot of DNAPL. There is little historic soil and groundwater data in the area of these two monitoring points. Consequently, the origins of these product compounds are unknown.

- The estimated volume of contaminated groundwater in the Copper Falls Aquifer, based on an average thickness of 40 feet, and an area of 480,000 ft^2 and 25 percent porosity, is 36 million gallons. The maximum estimated volume of DNAPL, based on an assumed thickness of DNAPL of 13 feet, an area encompassing approximately 8,600 ft^2, and a porosity of 25 percent, is 210,000 gallons. (The volume estimates for contaminated groundwater in the Copper Falls include the known extent in the upper bluff and Kreher Park ACs. The down gradient extent beyond the shoreline is unknown.)

- Estimated volumes of contaminated sediment have been prepared by SEH and Dames & Moore/URS. Based upon the conclusions of the SEH 1998 Ecological Risk Assessment an area of 410,000 square feet, or 9.4 acres, of impacted sediments has been identified. The SEH RAOR states that a wood waste layer of 9-inch average thickness is present over the contaminated sediments, and that the sediments vary from 0 to 7 feet of thickness over the site. The volume of contaminated sediments is estimated at 152,000 cubic yards, including approximately 4,000 cubic yards of wood waste. In 2001 URS performed a sediment investigation that further characterized the vertical extent of contaminated sediments. The lateral extent of contamination identified within the first six feet of sediments was essentially similar to that estimated by SEH. However, the presence of contaminants at greater depths was limited to discernible hot-spots. The report (June 2001) of that work concluded that these findings should be considered as part of the remedial approach for this area of concern.

Figures B-1 through B-10 (Appendix B) show the distribution of total PAHs and naphthalene on a recent aerial photo (1998) in the sediments. As previously described in Section 2.3.4, the highest levels of contaminants are found in the lobe of the inlet south of a line from the WWTP west to the marina, north of the WWTP, and along the shoreline east of the marina. This pattern closely mimics the shape of the shoreline, indicating the contaminants are likely a legacy of previous discharge along the entire shoreline length where Schroeder Lumber's operations were located. This is much different than what would be expected from a point discharge, which would resemble a classic fan shape. (Note Figures B-5 and B-6, which are cross-sections through the sediments east and west of the WWTP. Figure B-7, which is the east/west cross-section, shows the highest contaminant levels near the sediment surface. Figure B-5, the north/south cross-section east of the WWTP, shows the highest levels at deeper intervals.)

- Dames & Moore/URS prepared an estimate of the total quantity of gas produced during the operating life time of the MGP, and then subsequently derived the total estimated quantity of tar generated from those gas production values. Details of these estimates are included in a December 4, 1998 letter, which is included as an appendix to the March 1, 1999 D&M RAOR for the Ashland Lakefront Site. The estimated total tar quantity produced during the MGP's operating life was approximately 600,000 gallons. This volume was later corroborated by the Gas Technology Institute. The December 4, 1998 letter also quantified and referenced other volumes of tar disposition available from historic records provided by Xcel Energy. These other modes of disposition included tar sales and boiler fuel burning records. These volumes were peer reviewed and corroborated by the Gas Technology Institute – See, *Volumetric Estimates of DNAPL (Coal Tar) in the Environment and Total Tar Production from the NSP Former MGP Facility in Ashland, WI* (GTI, October 2000).

- Dames & Moore/URS also prepared an estimate of the volume of product present in the sediments, which was estimated at approximately 2 million gallons. GTI also independently estimated a volume of 2.3 million gallons present in the sediment.

3.2 POTENTIAL CONTAMINANT EXPOSURE PATHWAYS

3.2.1 Human Receptors and Exposure Pathways

Human receptors include recreational users of the park area (both adults and children), both city and Xcel Energy workers at the Upper Bluff and park areas, and residents including adults and children at the Upper Bluff. Additionally, trespassers (adults and children) potentially could be exposed to sediments in this area during spring summer and fall. Another potential receptor population includes those that consume fish caught near the sediment AC.

Potential contaminant exposure pathways to humans include incidental ingestion of contaminated soil or groundwater, inhalation of vapors from contaminated soil or groundwater, and physical contact with contaminated soil, groundwater, surface water, sediment, or coal tar. Minimal exposure can be expected from contaminated soil and groundwater via the incidental ingestion and physical contact exposure pathways because these pathways are not generally complete. Contaminated soil is located below relatively clean fill and/or pavements and structures, and groundwater is not a potable water source. Subsurface contamination on the Xcel Energy property is located beneath buildings and asphalt pavement beneath and south of St. Claire Street. North of St. Claire Street in the buried ravine and at Kreher Park relatively clean fill soil overlies the more contaminated soil and fill materials. Potential exposure scenarios for these pathways include construction workers encountering contaminated materials in excavation trenches in the backfilled ravine on the Xcel Energy property or at Kreher Park. Additionally, although groundwater in the vicinity of the Site is not utilized as a primary source of drinking water by the City of Ashland (the City municipal water supply is obtained from Lake Superior from an intake approximately 1,900 feet offshore of Kreher Park), two artesian wells screened in the Copper Falls Aquifer are located at Kreher Park. However, samples routinely collected from these wells indicate that the water is safe to drink.

Minimal exposure can also be expected from inhalation of vapors from soil or groundwater because potential migration pathways do not exist. As described above, clean fill, asphalt pavement and buildings overlie areas with contaminated soil. There are no currently occupied buildings with basements on either property overlying contaminated fill material and the shallow fill perched aquifers. (The former City of Ashland WWTP is built over contaminated fill material, but the building is currently vacant and not used.)

Because the underlying Copper Falls aquifer is confined, there is also no pathway for vapor migration from contamination in the aquifer; the low permeability Miller Creek formation behaves as a confining unit as well as a barrier to vapor migration.

The remediation of the former seep area in 2002 has eliminated exposure to contaminated soil and groundwater previously discharged at that area. However, exposure to sediment and contaminated surface water in the Chequamegon Bay inlet adjacent to Kreher Park would occur if people were to swim or wade in this area. Currently, swimming, wading and fishing in the area are restricted, and the area is well marked with warning signs and buoys.

3.2.2 Ecological Exposure Pathways

Various ecologic receptors may potentially be exposed either directly or indirectly through the food chain to contaminants associated with the sediments in the sediment AC.

Aquatic invertebrates, including benthic, epibenthic, pelagic and planktonic invertebrates, may potentially be exposed to chemicals in sediment and surface water through ingestion and direct contact or by absorption through their skin. They can also be exposed through their food. Aquatic plants potentially can absorb chemicals from sediment and surface water through their roots, leaves, or stems. Both aquatic invertebrates and aquatic plants can potentially serve as a major exposure pathway to upper trophic (food chain) levels since they are prey for fish, birds, and mammals although this is primarily a concern for those chemicals that are bioaccumulative.

Amphibians and reptiles may be exposed to chemicals in sediment and surface water along the shoreline through ingestion, dermal contact, and by feeding on contaminated aquatic invertebrates. Exposure may occur during feeding, early development of eggs and larvae, or burrowing. Amphibians and reptiles also may be a potential exposure pathway to birds and mammals through food chain transfer, again subject to the qualifier of bioaccumulation.

Fish may be exposed to chemicals in sediment and surface water through ingestion, dermal contact, uptake through gills, and by feeding on aquatic plants, invertebrates, or smaller fish. Exposure may occur during feeding, spawning, or burrowing. If any contaminants are bioaccumulative, aquatic vertebrates also may be a potential exposure pathway to birds and mammals through food chain transfer, assuming bioaccumulation.

Birds and mammals may be exposed directly to chemicals in the sediment and surface water through incidental ingestion, dermal contact, and inhalation. They may also be exposed indirectly through food chain transfer although as discussed previously, this exposure pathway is significant only for those chemicals that are bioaccumulative.

3.3 POTENTIAL ISSUES OF PUBLIC HEALTH

SEH's 1998 Human Health Risk Assessment (which was confined to Kreher Park and the bay sediments) concluded the following for potentially exposed human receptors:

- An unacceptable cancer risk existed for city workers from dermal contact with groundwater containing known carcinogens – for the entire Kreher Park site (both for current conditions at that time and for potential future site development);

- An unacceptable cancer risk existed for recreational children from dermal contact with surface soils – for the entire Kreher Park site (for potential future site development where subsurface soils could be potentially exposed at the surface);

- An unacceptable non-cancer risk existed for recreational children from dermal contact with groundwater containing non-carcinogenic contaminants – for the entire Kreher Park site (for future site development);

- An unacceptable cancer & non-cancer risk existed for all populations from dermal contact with seep water; an unacceptable cancer risk existed for city workers from ingestion and dermal contact with seep subsurface soils; an unacceptable cancer risk existed for trespassing adolescents from dermal contact with seep surface soils. (These conditions included both current settings at that time and future site development scenarios. However, the seep remedial action performed in 2002 has eliminated these potential conditions); and

- An unacceptable cancer risk existed for all populations from dermal contact with sediments (both for current conditions at that time and for potential future site development conditions).

The Wisconsin Department of Health and Family Services has also advised the public to follow a fish consumption advisory for Lake Superior. However, this is based on non-site related contaminants from other sources.

3.4 POTENTIAL ISSUES OF ENVIRONMENTAL CONCERN – SEDIMENT AREA OF CONCERN

Contaminated near shore sediments are located within the inlets created by the jetty and marina extension offshore from Kreher Park. The contaminants in these sediments originate from a number of historical operations including:

1) The former MGP;
2) Uncontrolled placement of wood wastes, soil, sand, and demolition waste material at Kreher Park;
3) Sawdust and wood waste from a series of sawmills that operated on the Ashland site from the early 1880s until about the mid-1930s were dispersed by natural forces, rain, flooding, storms and ice throughout Chequamegon Bay;
4) Log rafting and timber loading led to bark and wood waste accumulating to depths of many feet in various places in Chequamegon Bay;
5) Releases from wood treatment operations; and
6) Discharges from the Ashland WWTP .

Issues of environmental concern associated with the presence of contaminants in the sediments include:

- The potential availability of contaminants in sediments at concentrations that potentially cause direct adverse effects to aquatic and semi-aquatic organisms; and

- Contaminants in sediments potentially bioaccumulating in the food chain which can produce adverse effects in higher trophic level biota.

This RI work plan describes studies that will be conducted to acquire data, that in conjunction with previously collected data, can be used to evaluate whether the biological components in this near shore aquatic ecosystem are at risk of adverse effects from contaminants associated with these sediments. The biological components of this ecosystem that will be evaluated include benthic macroinvertebrates, finfish and wildlife, all of which are potentially exposed both directly, or indirectly though the food chain to these contaminants.

3.5 PRELIMINARY IDENTIFICATION OF RESPONSE OBJECTIVES AND REMEDIAL ACTION ALTERNATIVES

Potential remedial responses for The Upper Bluff/Filled Ravine and Copper Falls Aquifer were evaluated in the March 1999 Supplemental Facility Site Investigation and Remedial Action Options Evaluation Report prepared by DM/URS. In that report, DM/URS evaluated each alternative with regard to its expected (i) long term effectiveness, (ii) short term effectiveness, (iii) implementability, (iv) restoration time frame, (v) cost, and (vi) potential future liability in accordance with chapter NR 722, Wisconsin Administrative Code. After completing any initial screening of options, the following five alternatives were selected for detailed evaluation for the upper bluff area:[10]

1) Remedial Alternative OU-1A--No Further Action;
2) Remedial Alternative OU-1B--Low Permeability Cap;
3) Remedial Alternative OU-1C--Barrier Wall, Low Permeability Cap, and Groundwater Pump & Treat;
4) Remedial Alternative OU-1D--Limited Excavation of Soils; and
5) Remedial Alternative OU-1E--Six Phase Heating.

[10] The nomenclature used in the reports issued at that time utilized the operable unit terminology to refer to the areas of concern. The upper bluff/filled ravine was referred to as OU-1, the Copper Falls Aquifer as OU-2, Kreher Park as OU-3 and the affected sediments as OU-4.

Similarly, four alternatives were evaluated for OU-2:

1) Remedial Alternative OU-2A--No Further Action;
2) Remedial Alternative OU-2B--Groundwater Pump and Treat;
3) Remedial Alternative OU-2C--In Situ Groundwater Circulation Wells;
4) Remedial Alternative OU-2D--Dynamic Underground Stripping Using Steam Injection.

A rating was assigned to each criteria, and an overall score for each alternative was calculated. Costs ranged from the least restrictive (No Action at $0) to the most restrictive (Steam Injection at $25 million). A low permeability cap with groundwater monitoring (OU-1B), at a 40-year capitalized cost of approximately $600,000, was the recommended remedial alternative for the ravine fill (OU-1). Groundwater pump and treat (OU-2B), at a 40-year capitalized cost of $3.25 million, was the recommended alternative for the Copper Falls aquifer (OU-2).

SEH evaluated potential remedial alternatives in a December, 1998 report entitled Remediation Action Options Feasibility Study (FS) for the Ashland Lakefront Property consisting of the Kreher Park property and the near-shore contaminated sediments. These alternatives were prepared for the entire Kreher Park and bay sediments areas. Remedial alternatives evaluated in that report included the following:

1) Option A – No Further Action;
2) Option B – Access Restrictions and Institutional Controls;
3) Option C1 – Engineering Controls with a Thick Soil/Sediment Cap;
4) Option C2 – Engineering Controls with An Armored Cap;
5) Option D1 – Breakwater/Cutoff Wall Installed around Entire Site/Filling of Contaminated Sediments Area/In-Situ Remediation;
6) Option D2 – Breakwater/Cutoff Wall Installed around Entire Site/Partial Filling of Contaminated Sediments Area/Dredging of Remaining Sediments/Confined Sediment On-Site Treatment Facility/In-Situ Remediation;
7) Option E1 – Excavation/Separation/Treatment/Backfill;
8) Option E2 – Excavation/Off-Site Disposal/Clean Backfill; and
9) Option E3 – Excavation/Off-Site Disposal/No Backfill.

SEH rated the criteria and scored each alternative similar to the D&M/URS rating procedure. Costs ranged from $0 for No Action to nearly $90 million for Excavation and Off-Site Disposal with Clean Backfill. The best scoring options were the "D" series options. The 40-year capitalized costs for these ranged between $40 million (for D1) and $51 million (D2).

D&M/URS presented alternative remedial alternatives in its March 1999 RAOR for the Ashland Lakefront Site. The purpose of this alternative report was to fulfill the requirements of Paragraph 1(h) of the June 22, 1998 Spill Response Agreement between the WDNR and Xcel Energy. The alternative RAOR included: (1) a review of the December 1998 SEH report (Appendix A); (2) the application of SEH remedial standards for sediments, as well as Dames & Moore/URS remedial standards for sediments, to proposed sediment cleanup options (SEH remedial standards are based upon its October 1998 Ecological Risk Assessment (ERA); the application of D&M/URS remedial standards for sediments was based upon an alternative ERA submitted by D&M/URS under separate cover)[11]; (3) evaluation of applicable or relevant and appropriate requirements (ARARs); (4) identification and screening of potential remedial technologies; (5) detailed evaluation of selected technologies and a comparison of selected technologies, and (6) a recommendation for a remedial option based upon the foregoing.

The alternative study provided a detailed evaluation of nine targeted remedial alternatives, which ranged from a no action alternative, to capping of the sediments using partial bay filling along with an armored cap for the remainder of the affected sediments, and "hot spot" removal for source elimination, along with ozone sparging for groundwater remediation at Kreher Park. For comparison, SEH sediment cleanup limits and Dames & Moore sediment cleanup limits were evaluated separately. The list of evaluated alternatives include the following:

1) Option A - No Further Action;
2) Option B1 - Institutional Controls/Source Removal at Seep/Institutional Controls on Groundwater/Cap Sediments - SEH ERA Limits;

[11] These alternative standards were based upon an alternative method to establish an adverse effects concentration to benthic organisms proposed by Dames & Moore/URS. Although the results indicated a lower effects concentration using this method, it was later shown that a mathematical error caused this reduction. Once corrected, the effects concentrations using both the SEH method and the Dames & Moore/URS concentration were nearly the same. Regardless, the purpose of the alternative method was an attempt to use the existing SEH data from its 1998 Ecological Risk Assessment, which was insufficient. This was initially concluded by Dames & Moore/URS and later confirmed by USEPA.

3) Option B2 - Institutional Controls/Source Removal at Seep/Institutional Controls on Groundwater/Cap Sediments - D&M ERA Limits;
4) Option C1 - Institutional Controls/Source Removal at Seep/Cap Sediments/ Ozone Sparge at Kreher Park - SEH ERA Limits;
5) Option C2 - Institutional Controls/Source Removal at Seep/Cap Sediments/Ozone Sparge at Kreher Park - D&M ERA Limits;
6) Option D1 - Institutional Controls/Source Removal at Seep/Institutional Controls on Groundwater/Partial Filling of Bay/Cap Sediments- SEH ERA Limits;
7) Option D2 - Institutional Controls/Source Removal at Seep/Institutional Controls on Groundwater/Partial Filling of Bay/Cap Sediments - D&M ERA Limits;
8) Option E1 - Institutional Controls/Source Removal at Seep/Partial Filling of Bay/Cap Sediments/Ozone Sparge at Kreher Park - SEH ERA Limits, and
9) Option E2 - Institutional Controls/Source Removal at Seep/Partial Filling of Bay/Cap Sediments/Ozone Sparge at Kreher Park - D&M ERA Limits (see previous footnote No. 4).

A scoring system for each of the evaluation criteria described in ch. NR 722, WAC was developed for each alternative evaluated. The alternative that yielded the most desirable score was Institutional Controls/Source Removal at Seep/Cap Sediments/ Ozone Sparge at Kreher Park (C1/C2). However, Xcel Energy chose to recommend Institutional Controls/Source Removal at Seep/Partial Filling of Bay/Cap Sediments/Ozone Sparge at Kreher Park (E1/E2), an alternative with a higher score. Costs ranged from $0 for No Action to $15.5 million for Institutional Controls/Seep Removal/Partial Bay Filling/Cap Sediments/Ozone Sparge (E1). Cost was the only criterion that yielded a difference in scoring between the C series and E series scores, as all other criteria scored the same. As stated, the 4-year capitalized cost for the E1 option was approximately $15.5 million.

4.0 WORK PLAN RATIONALE

The Ashland Lakefront Site has been the subject of several investigations since 1995. The nature and extent of geologic as well as contaminant conditions have been fairly well defined. Although supplemental sampling for the upper bluff/filled ravine, Copper Falls Aquifer and Kreher Park areas (ACs 1, 2 and 3) as described in this work plan will refine this understanding, the remedial actions that will be determined for ACs 1, 2 and 3 in the ROD for this site will likely fall within the universe of options previously studied (see Section 3.5). Accordingly, the work plan rationale and associated data quality objectives (DQOs) for the work proposed for the first three ACs are concise and straightforward. However, the agencies recognize that the previous risk assessment studies are deficient, and consequently, a formal DQO process and Problem Formulation particularly with regard to AC 4 are required to support both a Baseline Human Health Risk Assessment and Baseline Ecological Risk Assessment. Xcel Energy believes that the ongoing remedial investigation process and the future risk management decision-making will benefit now from a more formal and systematic integration of concepts introduced in the guidance for managing contaminated sediment sites (USEPA 2002) into the risk assessment process.

During the Technical Scoping meeting held at Region V on January 8, 2004, USEPA indicated that Xcel Energy could propose two alternatives in this work plan for an approach to address the contaminated sediments AC. The first alternative will consist of a traditional sampling plan including the rationale, proposed sampling program and environmental data that will be derived. Based upon the level of information previously generated, including sediment chemistry and previous bioassay data, the sampling program will be designed to obtain data necessary to arrive at a cleanup standard following a standard CERCLA investigation. The results of the investigation will be provided to the community through the community involvement process of notifications and public meetings. The second alternative will follow the Problem Formulation process as described in the Managing Contaminated Sediment Risk guidance (USEPA 2002), and advocated by the CSTAG following its meeting in Ashland in July 2002. Details of each alternative and the respective approach are described in Sections 4.2.2 and 4.2.3, respectively.

The following sections briefly describe the process needed to finalize the RI/FS Work Plan and provides Xcel Energy's recommendations for the studies needed to fill the data needs.

4.1 DATA QUALITY OBJECTIVES

4.1.1 The Data Quality Objective Process

The DQO process is described in USEPA guidance as "a seven-step planning approach to develop sampling designs for data collection activities that support decision making. This process uses systematic planning and statistical hypothesis testing to differentiate between two or more clearly defined alternatives". It is recommended by USEPA in RI/FS guidance (USEPA 1988) and ecological risk assessment guidance (USEPA 1997; 1998). The USEPA developed the DQO process "…as the Agency's recommended planning process when environmental data are used to select between two opposing conditions." A summary of the seven steps involved in the DQO process is presented in the table below (from USEPA 2000).

The Data Quality Objective Process

DQO Step	Activity
Step 1. State the problem.	Define the problem; identify the planning team; examine budget and schedule.
Step 2. Identify the decision.	State decision; identify study questions; define alternative actions.
Step 3. Identify inputs to the decision.	Identify information needed for the decision (information sources, basis for Action Level, sampling/analysis method.)
Step 4. Define the boundaries of the study.	Specify sample characteristics; define spatial/temporal limits, units of decision making.
Step 5. Develop decision rule.	Define statistical parameter (mean, median); specify Action Level; develop logic for action.
Step 6. Specify tolerable limits on decision errors.	Set acceptable limits for decision errors relative to consequences (health effects, costs).
Step 7. Optimize the design for obtaining data.	Select resource-effective sampling and analysis plan that meets the performance criteria.

The specific goals of the general DQO process are to:

- Clarify the study objective and define the most appropriate types of data to collect;
- Determine the most appropriate field conditions under which to collect the data; and,
- Specify acceptable levels of decision errors that will be used as the basis for establishing the quantity and quality of data needed to support risk management decisions.

4.1.2 Site Data Quality Objectives

DQOs have been prepared to ensure that data proposed for collection would be of sufficient quality, appropriate for the intended uses, and useful in meeting RI/FS objectives. The overall QA objective of the project is to ensure that field and laboratory data collected during the RI is precise, accurate, representative, comparable, and complete. Specific procedures for obtaining these QA objectives will be presented in the QAPP described in Section 5.1 below. DQOs for the Site include the following:

- Utilize laboratory procedures and the appropriate analytical support (i.e. data validation) for identifying contamination consistent with the levels for remedial action objectives identified in the NCP.

- Identify the vertical and lateral extent of soil and groundwater contamination in the Upper Bluff / Filled Ravine, the vertical and lateral extent of groundwater contamination in the Copper Falls Aquifer, the lateral extent of soil and groundwater contamination at Kreher Park, and the lateral and vertical extent of sediment contamination for the Chequamegon Bay Inlet utilizing historical and RI generated data;

- Further characterize the lateral and vertical extent of DNAPL in each AC;

- Utilize historical and RI generated site data to interpret geologic and hydrogeologic conditions with respect to evaluating contaminant migration pathways and the fate and transport of contaminants;

- Generate laboratory data with appropriate detection limits to compare to media specific cleanup standards and to assess attainment of risk-based criteria.

- Analyze historic and RI generated groundwater data with respect to Wisconsin groundwater quality standards (Preventive Action Limits (PAL) and Enforcement Standards (ES) per Wisconsin Administrative Code NR 140. (It is likely that the standards will apply as an ARAR.)

- Analyze historic and RI generated soil data with respect to Wisconsin soil clean-up standards (residual soil contaminant levels (RCLs) and soil screening levels (SSLs) per Wisconsin Administrative Codes NR 720 and 746, respectively; standards will likely apply as an ARAR).

- To utilize historic and RI generated data necessary to perform human health and ecological risk assessments; To utilize historic and RI generated data necessary to develop site-specific cleanup standards protective of human health and the environment; and

- To utilize historic and RI generated data for the evaluation of potential remedial alternatives that will achieve site-specific cleanup standards protective of human health and the environment.

A detailed discussion of these DQOs is presented in the Quality Assurance Project Plan (QAPP) that accompanies this work plan.

4.2 WORK PLAN APPROACH

As previously described, two alternatives for evaluating the contaminated sediments are presented in this work plan. Because this discussion necessarily segregates the sediments from the upland ACs, the following section describes the rationale and approach for these upland areas.

4.2.1 Upland Area Investigation

The primary investigation tasks described herein were developed through a joint effort in a series of technical meetings among USEPA, the WDNR, Xcel Energy and their representatives during Fall 2002 and Winter 2003. These tasks were described in the Revision 00 work plan submitted on August 22, 2003. The results of the review and incorporation of the SEH work plan, the technical letter report (TLR), and discussions at the January 8, 2004 scoping meeting have led to the following technical approach:

4.2.1.1 Upper Bluff / Filled Ravine

The upper bluff/filled ravine has been extensively investigated with regard to groundwater and subsurface soil conditions. These investigations identified groundwater flow and water quality conditions in the ravine, DNAPL in the ravine south of St. Claire St., and the buried clay tile that was the source of the seep at Kreher Park. However, a thorough grid of subsurface soil samples across the ravine fill to investigate the known locations of former gas holders and other potential sources at the MGP site has not been performed. In addition, the collection of surface soils for purposes of human health risk associated with the former MGP has not yet occurred. Finally, an evaluation of potential volatile vapor compounds that could also prove to be a risk to residents and workers in the area of the upper bluff has not yet been performed. The upper bluff sampling program will therefore consist of the following:

- Collection of surface soil samples around the former MGP, along with background samples from topographically up gradient locations;

- Collection of soil samples from borings advanced in the vicinity of the former MGP to further characterize the lateral and vertical extent of contamination in the filled ravine south of St. Claire Street; this will be based on a narrow sample grid to confirm potential sources at individual gas holder and tank locations that appear on Sanborn maps;

- Collection of groundwater samples from all ravine fill and Miller Creek water table wells; these wells were sampled in the early years of the investigations (1995 – 1997), but with the exception of water levels, have not been since monitored for water quality. Updated water quality information is important in the fill and Miller Creek since flow conditions have changed because of the clay tile investigation (deep excavations) made in the storage yard in 2001, and the pumping well (EW-4) that has removed groundwater from the mouth of the ravine since 2002.[12]

- Conduct an air emission investigation to evaluate the potential inhalation pathway for exposure to potential hazardous vapors generated at the site; this will include a soil vapor

[12] Details of the proposed groundwater collection program are described in Section 5.0. Xcel Energy proposes that the sampling program be reviewed following the first two rounds to determine if the sampling list (e.g. metals such as hexavalent chromium, which has a 24-hour hold time) and well network can be reduced.

sampling program in the ravine fill, as well as an ambient and indoor air sampling program within structures in proximity of the filled ravine. The data collected from the soil probes will be modeled using a variation of the Johnson and Ettinger soil-vapor migration model, and compared to the results of the indoor air data.[13] (This program was based, in part, on input from Mr. Henry Nehls-Lowe's January 7, 2004 memorandum on site vapor migration concerns to the WDNR.)

The surface and subsurface soil sampling program described above was conditionally approved by USEPA on September 25, 2003.

4.2.1.2 Copper Falls Aquifer

The primary contaminant feature in the Copper Falls Aquifer is the DNAPL pool that is thickest beneath the courtyard of the Xcel Energy property, and thins in the down gradient direction (north), but is found at the upper reaches of the aquifer immediately beneath its contact with the Miller Creek. Four new piezometers were installed during December 2003 following the conditional approval of the August 22, 2003 (Rev 00) work plan. These wells included piezometers MW-15A, -15B and -21B, installed between 35 and 57 feet in depth, and MW-2C, installed at 197 feet in depth. Nearly four feet (3.75') of product was measured in MW-15A, screened at the top of the Copper Falls (at 35 feet) about one week following development. Product was not measured in MW-15B or -21B, installed at depths of 57 and 55 feet, respectively. However, elevated levels of benzene (>400 µg/L) were measured in samples from both wells, indicating product may be near the screen or infiltrate the well in the future. Only trace levels of total petroleum constituents (33 µg/L) were measured in the sample from MW-2C, installed intersecting the upper bedrock at nearly 200 feet.

The interim tar removal system has recovered more than 7,000 gallons since it began operation in late 2000. Although this is a low flow system, this is largely due to the large volume of tar estimated within the free-product plume. The proposed sampling program is intended to better define the extent of the free-product plume, as well as provide better information on the down

[13] The Johnson and Ettinger model and its variants couple fate and transport processes which include: Source zone partitioning to determine source vapor concentrations; transport across the vadose zone by diffusion which may include biodegradation; transport by diffusion and advection across the soil surface and, if present, a surface barrier such as asphalt or a building foundation; and dispersion in indoor or ambient air assuming uniform mixing in a building or breathing zone.

gradient extent of the dissolved phase plume. Additional piezometers will be installed at Kreher Park. Three of these (MW-7B, -23A and -23B) were part of the conditional approval. Three other piezometers proposed as part of the SEH work plan will be installed along the shoreline of the affected sediments area. Combined with the existing well network, the additional piezometers will provide the furthest down gradient information on water quality data in the Copper Falls.

Samples of free-product and soil will be collected to evaluate the physical properties of the product interacting with the soil matrix. This will provide data on the disposition of the free-product. Interface tension and residual saturation tests will be conducted on samples to perform an evaluation about its state, whether static or migrating, as well as allow a prediction on further future recovery. Further analyses on the Copper Falls Aquifer will be restricted to collecting and evaluating future water quality data.

Groundwater modeling on the dissolved phase plume is not recommended. Samples of the aquifer material will be collected for total organic carbon analysis. However, groundwater modeling will not provide useful data. The model cannot be calibrated because down gradient conditions beyond the shoreline can only be determined with offshore drilling. The WDNR explained at the January 8, 2004 scoping meeting that its policy on groundwater-surface water interaction must be addressed. This policy states that shoreline wells yielding samples with contamination assumes that contaminants discharge to the surface water body. Regardless, the artesian conditions known to exist at Copper Falls Aquifer wells installed at Kreher Park confirms that this aquifer has no hydraulic connection with the near shore sediments. Although physical laws require that the artesian pressures must be alleviated, either through direct discharge to the surface water or that a stagnation zone is present, the WDNR policy cannot apply to the deep aquifer.

The approach to the delineation of water quality in the Copper Falls Aquifer will depend on the results of data developed from the proposed shoreline piezometers. Existing piezometers at Kreher Park indicate that the dissolved phase plume is very thin, at the top of the aquifer. The shoreline wells may yield declining water quality data, indicating the dissolved phase plume is at a steady state condition. Conversely, if the water quality from these proposed piezometers is comparable to the up gradient Kreher Park wells, further down gradient wells installed at the end of the marina and the end of the Prentice Avenue boat launch may be considered. Note that these potential wells are not recommended until initial water quality data from the shoreline wells is collected.

The proposed sampling program in the Copper Falls Aquifer will consist of the following:

- Installation of the three approved piezometers in Kreher Park at the bluff face named above (MW-7B, -23A, -23B), and three piezometers along the shoreline (MW-24A, -25A and -26A) and subsequent collection of six rounds of groundwater samples from all Copper Falls piezometers to further characterize the lateral and vertical (in particular to determine if bedrock is affected) extent of groundwater contamination in the aquifer;

- Conduct a borehole geophysical survey to verify subsurface geologic units, and perform a visual (downhole camera) inspection of two artesian wells at Kreher Park;

- Collect samples of DNAPL and aquifer materials to evaluate the physical properties of the tar/water/soil matrix for future evaluation of the free-product plume; this will consist of interface tension, residual saturation, viscosity and density measurements.

4.2.1.3 Kreher Park

Kreher Park is characterized by widespread groundwater contamination of dissolved phase benzene, naphthalene, and to a lesser extent associated petroleum constituents and PAHs. The area is overlain by a thin (1 – 3 feet) layer of relatively clean fill, which is underlain by rubble, slab wood and general soil fill that is contaminated with coal tar and other solid waste materials. Free-product (DNAPL) historically was measured at the seep where the clay tile that appeared to extend along the base of the filled ravine discharged. Since the 2001 (installation of the extraction well at the ravine mouth) and the 2002 (seep excavation and cap) interim actions, there has been no surface coal tar discharges.[14] DNAPL was recently measured at TW-11 north of the WWTP. Because of this finding, a separate investigation to characterize the extent of this product pool will be performed as part of this RI.

[14] Monitoring well MW-7 was abandoned at the time of the seep interim action. This well will be replaced and monitored during the RI to further measure potential free-product conditions at this location.

Discussions at the January 8, 2004 technical scoping meeting concluded that surface water and air samples from the interior of the former WWTP are unnecessary. The WDNR reported that the basement areas are completely flooded, indicating that interior water and air samples would not provide useful information on constituents or source areas. WDNR suggested at the time of the meeting that Xcel Energy should consider an exterior soil vapor probe at the park in the vicinity of the WWTP as an alternative. However, this sampling is not recommended. The groundwater at Kreher Park contains elevated levels of benzene. This compound will likely be measured in soil/vapor probe samples. Because there is no interior dwelling at the Park, there is no potential risk. Consequently, unlike the upper bluff/filled ravine, a soil vapor migration evaluation is not recommended at Kreher Park.

Investigation of the Kreher Park area will focus on the former municipal disposal area to the west, the former coal tar dump area between the seep and the WWTP, the free-product pool at TW-11, former utility corridors, and the groundwater/surface water/sediment interaction at the shoreline. Modifications to the Revision 00 work plan include the addition of more test pits at the municipal disposal and coal tar dump areas, investigation of the extent of free-product at TW-11, and a systematic evaluation of the groundwater/surface water interaction. The proposed test program at the park will consist of the following:

- Test pits will be advanced in accordance with the proposed Revision 00 work plan around the peripheries of the former disposal area and the coal tar dumps to delineate the boundaries of these areas. In addition, internal test pits will be advanced within the limits of these areas to identify soil/waste conditions and collect samples for characterization and analysis. A particular feature that will be investigated will be the former open sewer that trends northwest across the western portion of the park (within the limits of the former disposal area) as it appears on Sanborn maps. If sheen is encountered in any of these test pits, additional pits will be stepped out until no sheen is encountered. Care will be exercised to avoid encroaching upon the existing cap installed for the seep remediation. Additional test pits will be advanced along the north boundary of the coal tar dump near the intersection of Marina Drive to investigate the potential trace of a culvert identified on one of the Greeley and Hanson record drawings.

The boundaries of the former disposal and coal tar dump areas identified in the field will be staked and surveyed.

- If representative samples cannot be retrieved from the test pits because of caving or obstructions, the same area will be investigated and sampled with a Geoprobe. Soil/waste samples will be collected at these locations in the event of sampling restrictions during test pit advancement.

- Geoprobe samples will be advanced in the areas of the seep and TW-11 to characterize the extent of free-product at those locations. Samples of soil will be collected and visually classified to characterize the potential presence of free-product. Samples will also be collected for analytical characterization.

- Geoprobe samples will be advanced along utility corridors where former conduits or drainage ways are identified. Samples will be classified an submitted for analyses.

- Monitoring wells will be installed with screens intersecting the water table at the same locations as the shoreline wells installed in the Copper Falls aquifer. Additionally, piezometers installed with short (2- 3') screens will be nested with these wells to collect information on vertical water movement. These new water table wells along with the existing water table wells at Kreher Park, and proposed MW-7R (if less than one-foot of product is present), will be sampled for water quality in accordance with the routine quarterly schedule. The one-inch diameter wells will be monitored for water levels only. The information derived from these wells will allow a determination of both the flow and contaminant mass-loading to surface water.

4.2.2 Chequamegon Bay Sediments - Alternative 1 – Sampling Design Strategy

4.2.2.1 Introduction and Rationale

The relevant portions of the Field Sampling Plan is designed to provide sufficient information to support risk management decisions related to the presence of elevated levels of contaminants of potential concern (COCs) in the Bay sediments. Five tasks have been identified to meet the objectives of the RI:

Completion of previous sediment studies;
Sediment quality triad (Triad) evaluation;

Tissue sampling;
- Sediment stability Studies; and
- Conduct of a Baseline Ecological Risk Assessment (BERA).

Risk to ecological receptors resulting from exposure to site-related COCs will be assessed using data collected from the Triad and tissue sampling tasks identified above. The objective of the Triad evaluation is to determine the COC concentration in sediment that results in unacceptable risk to benthic invertebrate communities as well as fish and wildlife that potentially depend on these organisms. Tissue sampling data will be used to support risk estimation and characterization in the BERA and to provide a baseline from which to evaluate potential post-remediation bioaccumulation of COCs. The analyses proposed for each study and their utility for achieving study objectives are summarized in Exhibit 4-1.

An evaluation of sediment stability is also proposed as part of this work plan. The objective of the proposed sediment stability studies is to evaluate the potential for contaminants at depth in the sediment column to be remobilized by the natural dynamics, or boating activities in the sediment AC area. These studies will also evaluate whether or not the sediment is stable in portions of the site, and the degree to which sediment deposition can lead to natural recovery of all or portions of the site. This in turn will be determine whether monitored natural recovery is a viable option for portions of the site.

Finally, this work plan proposes to conduct a BERA following the USEPA Ecological Risk Assessment for Superfund (ERAGS) guidance (USEPA 1997). The BERA will be initiated by updating Step 3 in the ERAGS process, the Baseline Ecological Risk Assessment Problem Formulation. The BERA Problem Formulation will be revised to reflect the additional information that results from the studies described in this work plan.

This RI work plan for Bay sediments was developed in accordance with the principles outlined in *Data Quality Objectives (DQO) Process for Hazardous Waste Site Investigations* (USEPA 2000a). The DQO process provides "…a systematic approach for defining the criteria that a data collection design should satisfy, including: when, where, and how to collect samples or measurements; determination of tolerable decision error rates; and the number of samples or measurements that should be collected" (USEPA 2000a). The seven steps of the DQO Process are described in Section 4.1.1.

Exhibit 4-1 **Summary of Analysis for Sediment Quality Triad and Tissue Sampling Studies.**

Assessment Endpoint	Line of Evidence/ Measurement Endpoint	Use	Potential Uncertainties Affecting Use in Sediment AC
Survival, growth, and reproduction of benthic macroinvertebrate communities.	Sediment bioassay using invertebrate test organism	Determine a dose-response relationship between COC concentrations in sediment and pore water and invertebrate toxicity. Results can be directly applied to determine a preliminary remediation goal (PRG).	Does not provide measure of *in situ* toxicity. Laboratory conditions may vary from dynamic conditions in sediment in Chequamegon Bay.
	Benthic macroinvertebrate community analysis	Determine whether community-level impairment exists in study area sediments relative to reference area sediment	Benthic macroinvertebrate communities are naturally variable. It is difficult to differentiate between natural variability and site-related impacts.
	Analysis of sediment and pore water concentrations of COCs	Determine whether COC concentrations in sediment and pore water exceed relevant toxicological reference values (TRVs) for benthic receptors.	Although more realistic than generic sediment quality guidelines, TRVs may not accurately predict the incidence of toxicity in site sediments.
Survival, growth, and reproduction of fish communities.	Analysis of sediment and pore water concentrations of COCs	Determine whether COC concentrations in sediment and pore water exceeds appropriate toxicity reference values (TRVs); and levels associated with deformities, fin erosion, or other histopathological effects in fish as derived from the literature.	Although more realistic than generic sediment quality guidelines, TRVs may not accurately predict the incidence of toxicity in site sediments. Histopathological effects in fish as derived from the literature may not accurately predict the presence of histopathological effects present at the Site.
	Analysis of fish tissue residues of COCs	Determine whether COC concentrations in fish tissue at the site exceed: • Concentrations of fish tissue residue at reference locations; and • Critical body residue TRVs Provides empirical data for food-chain modeling.	Results cannot be directly applied to determine a PRG. Fish are mobile and are likely exposed to a range of sediment concentrations. Critical body residue TRVs derived from the literature are not site-specific and may not accurately predict the incidence of toxicity in site sediments.
Survival, growth, and reproduction of aquatic dependent wildlife.	Food-chain modeling	Determine if the average daily dose (ADD) of COCs exceeds the no effect dose (NOAEL) or low effect dose (LOAEL) for aquatic-dependent wildlife.	Modeling approaches are abstractions of reality so may not accurately represent site specific food chain dynamics.

4.2.2.2 Completion of Previous Sediment Studies

From the existing GIS platform, which has incorporated all historical sediment and water quality data from the sediment AC, a variety of figures will be produced to help support the sediment AC work plan as discussed in the following sections. These may include COC isopleths to support station selection and vertical sections showing COC concentrations with depth to support the analysis of sediment stability.

4.2.2.3 Sediment Quality Triad Evaluation

A Triad approach will be conducted to evaluate the potential for risk to sediment-dwelling invertebrates. The Triad approach evaluates sediment quality by integrating spatially and temporally matched sediment chemistry, biological, and toxicological information (Long and Chapman, 1985; Chapman et al. 1987). Benthic invertebrate community analysis and sediment toxicity testing provide site-specific information regarding potential ecological effects of exposure of ecological receptors to COCs in the sediment AC. These additional lines of evidence supplement traditional sediment chemistry data to provide a more relevant, site-specific assessment of risks.

The Triad approach is appropriate for sediment investigations of Chequamegon Bay. The approach was originally developed for estuarine systems, namely Puget Sound and San Francisco Bay (Long and Chapman, 1985; Chapman et al. 1987). However, numerous freshwater sediment investigations, including those conducted in the Great Lakes region, have utilized the Triad approach. As part of the Great Lakes National Program of USEPA, Rediske et al. (2001) and Rediske et al. (2002) used the Triad approach to investigate the extent of sediment contamination in Manistee and Muskegon Lakes, respectively. Manistee and Muskegon Lakes are relevant to Chequamegon Bay because they are geographically similar and are impacted by the presence of PAH compounds.

The objective of the Triad approach for the Ashland site is to incorporate site-specific ecological effects information to determine the COC concentration in sediment that results in unacceptable risk to benthic invertebrate communities as well as fish and wildlife that potentially depend upon these organisms. The conclusions developed from the Triad approach may be used to support remedial decision-making for the site.

4.2.2.3.1 Sediment Triad Design Strategy

A comprehensive study design is essential for drawing reliable conclusions from the Triad approach. The reliability of the Triad approach is dependent on the collection of sufficient spatially- and temporally-matched sediment chemistry, benthic invertebrate community, and sediment toxicity data.

In previous investigations at the site, confidence in the results of the Triad approach was limited by shortcomings in one or more lines of evidence (SEH 1998a; SEH 2002). In the initial risk assessment (SEH 1998a), the strength of the benthic invertebrate component of the Triad was limited by insufficient sampling locations to account for natural variation in benthic invertebrate communities; the sediment toxicity line of evidence had an insufficient range of total PAH concentrations necessary to elucidate a dose-response relationship. The sediment toxicity line of evidence was strengthened in the supplemental risk assessment (SEH 2002) by evaluating a greater range of total PAH concentrations; however, additional benthic invertebrate community analysis was not performed.

Xcel Energy proposes an expanded scope of the Triad study design so that it will yield results upon which decisions regarding potential remedial action can be based. The recent RI work plan developed by SEH (2003) expanded the scope of previous investigations, however Xcel Energy believes that the number of Triad sampling locations should be increased to develop sufficient data necessary to determine statistically significant differences in benthic invertebrate communities between reference and study areas. This increase in sample size is required to better characterize the natural variability inherent in benthic invertebrate communities. Increasing the number of samples will strengthen the benthic invertebrate community assessment, increase confidence in all three lines of evidence, and subsequently increase confidence in the overall conclusions of the Triad approach.

The following sections detail the rationale for the study design, including the distribution and number of samples, the selection of reference areas, and the statistical analysis of data. These sections were developed consistent with Step 6 (Specify Limits on Decision Errors) and Step 7 (Optimize the Design for Obtaining Data) of the DQO process.

4.2.2.3.1.1 Distribution and Numbers of Samples

A key objective in determining the distribution of sampling locations is to ensure that the spatial coverage of samples reflects a gradient of total PAH concentrations in sediment as well as controls for any potentially confounding variables which may affect the results of the studies. Potentially confounding variables to be considered in selecting sampling locations in the sediment AC include the presence of wood waste in the sediment, substrate grain size, and water depth (using water depth as a variable incorporates other variables including energy regime and light penetration). Information obtained from previous investigations of Bay sediments (SEH 1998a; SEH 2002) was considered in the sampling location selection process.

Previous sediment investigations indicated that wood waste associated with historical log booming operations or fill material used to create the Ashland Lakefront Property was present in many areas of the Bay (SEH 1998a). Even in the absence of contamination, the abundance and distribution of benthic invertebrates is likely to differ in sediments containing wood waste relative to mineral substrates, i.e., sand, silt, etc.

Sediment chemistry data collected in previous investigations (SEH 1998a; SEH 2002) will be used to guide selection (See Section 4.2.2.2) of Triad sampling locations within each substrate type and depth regime. Sampling locations will be distributed across total PAH concentrations ranging from approximately 2 to 400 mg/kg to represent a range of concentrations which should encompass those where potential ecological effects thresholds are likely to be found. A distribution of sampling locations across a range of total PAH concentrations is necessary to elucidate reliable dose-response relationships between sediment COC concentrations and ecological effects.

The exact location of sampling locations will be determined based on the results of a reconnaissance study. The reconnaissance study will include a survey of sediments for the occurrence of wood waste and qualitative assessment of substrate grain size. This survey will employ diver observations, underwater video or trial grab samples as necessary to confirm tentative sampling locations and assure that potentially confounding variables are adequately represented in the sampling design.

4.2.2.3.1.2 Selection of Reference Areas

The selection of appropriate reference locations is critical to the Triad sampling design strategy. Triad results from reference sampling locations serve as the benchmark to evaluate results from potentially impacted sampling locations in the sediment area of concern so that differences in the results of sediment bioassays and benthic community structure that are attributable to natural factors, i.e. variability in substrate composition and depth, can be differentiated from differences attributable to the presence of COCs.

Previous investigations relied on two reference locations to characterize natural variability in reference benthic communities: one sampling location in sediments having wood waste material and one sampling location in mineral sediments (SEH 1998a). The results from two reference locations of varying substrate types are insufficient to adequately characterize the spatial heterogeneity of natural benthic communities. In the Triad study proposed in this work plan three separate reference locations will be selected. The criteria for selection of these reference locations will include the following:

- Reference area sediments have lower concentrations of COCs relative to study area sediments;
- Substrate characteristics in the reference locations encompass the range of substrate characteristics found in the Bay sediments;
- The chemical composition of the sediments (i.e., total organic carbon, depth of oxidation-reduction potential layer, etc.) other than the presence of COCs is expected to be similar to that found in the Bay sediments within or close to Chequamegon Bay; and,
- Flow dynamics and sedimentation regimes are similar to those in the study area.

Application of the above criteria for selecting reference areas for the BERA will also consider data usability for potential Natural Resource Damage Assessment (NRDA) purposes, including:

- Methods used to collect data at the control area should be comparable to those used at the assessment area;

- Data from control areas should be compared to values in the scientific or management literature to demonstrate that the data represent a normal range of conditions; and

- Control areas may be used for determining the baseline for more than one resource if the sampling and data collection for each resource do not interfere with sampling and data collection for the other resource (43 CFR Part 11.72).

Tentative reference sampling locations are illustrated in Figure 13. The exact distribution of reference sampling locations will be determined after a reconnaissance study. As with selection of the site study locations, the reconnaissance study will include a survey of areas for the occurrence of wood waste and qualitative assessment of substrate grain size and will employ diver observations, underwater video or trial grab samples as necessary to confirm tentative sampling locations and assure that potentially confounding variables are adequately represented in the sampling design.

4.2.2.3.1.3 Basis for Sampling Design

A primary objective of the experimental design for the sediment AC is to evaluate the effect of the presence of contaminants in the sediment (total PAH will be used to represent all contaminants for this discussion) on benthic macroinvertebrate community structure when compared to the benthic community from uncontaminated reference areas.

Of the many techniques for making comparisons between entities, none is better grounded than the method of general linear models (GLM), the general term for a method that includes t-tests, analysis of variance (ANOVA), analysis of covariance (ANCOVA), linear regression, and other methods which take the form of the general model. While GLM does make particular assumptions about the data (e.g., observations are independent, variances are equal, errors are normally distributed, etc.) it is robust to mild deviations from these assumptions. In fact, recent research has demonstrated that even when data are strongly deviant from these assumptions, transformation of the data to ranks allows the use of GLM as the equivalent of standard nonparametric rank procedures such as Kruskal-Wallace and Friedman nonparametric ANOVA while retaining the flexibility of generating a specific model for a particular purpose (Potvin and Roff 1993). As Snedecor and Cochran (1967) point out, " With non-normal data from a continuous distribution, the efficiency of the rank tests relative to the *t* never falls below 86% in large samples and may be much greater than 100% for distributions that have large tails."

GLM analysis will permit testing for differences between contaminated and reference sites that also differ in other attributes such as sediment texture, depth, and amount of woody debris in the sediments. Within GLM the technique of ANCOVA allows removal of the effects of these extraneous variables, so that their contributions to variance in community structure will not confound differences, or lack of differences, between contaminated and reference sites.

Power analysis, the statement of the probability of rejecting a null hypothesis (e.g., of no difference between contaminated and reference sites) when that hypothesis is false, is also straight forward with GLM. Power analysis allows the computation of the number of samples required to detect a difference (effect) of a stated size.

Cohen (1977) has posited some standards for declaring an effect to be significant: a small effect is a difference of 0.2 standard deviation (sd); a moderate effect is 0.5 sd; and a large effect is one of 0.8 sd. These apparently simple rules require interpretation depending on the model used (Dallal et al. 2000). For example, the effect size in a one-way ANOVA in which two group means differ by 0.8 sd is 0.4 sd; while the two means differ by 0.8 sd, each differs from the grand mean by 0.4 sd, and the effect size is therefore 0.4 sd**.** The smaller the effect to be declared significant, the more samples are required. Obviously, there is a tradeoff between sample size and the size of the effect to be declared significant. Constraints on the number of samples that can feasibly be taken and analyzed generally rule out the detection of small effects as significant, unless the effect might have an overwhelming effect on human health, etc.

For this study, alpha, the probability of rejecting a null hypothesis when it is actually true, is set at 0.05. Beta, the probability of failing to reject a null hypothesis when it is actually false is set at 0.2; thus the power (1 – beta), the probability of rejecting a false null, is set at 0.8. Preliminary data on benthic invertebrates from the SEH (1998) benthic study were used to generate estimates of within reference group mean and standard deviation for the following variables: total number of mollusks and crustaceans (m+c); total number of species found (S); and total number of individuals found (N). These last two variables, S and N, are components of synthetic species diversity indices (e.g., Shannon-Wiener, Simpson) and are in themselves estimators of species diversity in a community (Magurran, 1988). Thus, they have some utility in characterizing overall benthic community structure.

For an initial power analysis (using SYSTAT v.10.03; Dallal et al. 2000) a one-way ANOVA was chosen as the model. Power analyses were conducted on raw means and standard deviations from the preliminary data from the reference stations (SEH 1998), as well as means and standard deviations of ranked data, just in case this transformation will be needed in the final analysis of the data. These power analyses are presented in Appendix D, along with the means and sds used in the analyses. Generally speaking, in a balanced design around 17-20 samples each from both the sediment AC and from the reference sites will be needed to meet the standards set *a priori* for detecting differences in benthic community variables. Fewer samples would reduce the power below 0.8 or increase the size of the difference that could be detected as significant at alpha=0.05. Based upon these power analyses it became apparent that it would be economically infeasible to take sufficient samples to detect anything more than a relatively moderate effect, i.e. a difference of 1.0 sd between largest and smallest means and an effect size of 0.5 sd. From the graphs, shown in Appendix D, to detect a small effect [based upon Cohen's (1977) definition ~0.2 sd] with the same alpha and power would take around 100 samples.

The experimental design selected to evaluate the effects of contaminants on benthic community structure will be a randomized block design: in the contaminated area, eight stations will be selected along a total PAH gradient from approximately 2 μg/g to 400 μg/g, and five replicate samples will be randomly taken from the vicinity of each station, giving a sample size of 40 from the contaminated area. Three reference areas will be selected, and five replicate samples taken from each, for a total sample size of 55. As the noncentrality parameter required for power analysis is the same for treatment effects in a randomized block design as it is for effects in a one-way ANOVA (Dallal et al. 2000), the results of the initial power analysis are applicable to the randomized block design, the additional samples (55 versus 34-40) compensating for the unbalanced design with increased sample size.

The reason an unbalanced design with more samples from the contaminated area was chosen was so that in addition to potential differences between reference and sediment AC sites, trends within the sediment AC, (e.g. changes in benthic structure with increasing concentrations of total PAH) may be elucidated using ANCOVA models. These models can not only quantify change, they can also remove covariate effects such as depth and substrate type which would potentially confound the relationship between total PAH and community structure. Using the proposed randomized blocks design with sample size of 40 in the sediment AC, these ANCOVA models are also quite powerful.

For example, suppose that a covariate (such as presence of wood chips) explains 20% of the variance in a parameter of community structure (i.e., the coefficient of determination, $R^2 = 0.2$). To detect an additional effect of total PAH on the parameter explaining an additional 15 % of the variance (i.e., total $R^2 = 0.35$) the proposed design of 40 samples would have a power of 0.832 to declare the 15% increase in R^2 as significant at alpha=0.05 (see power curves in Appendix D). [This power analysis was performed using SamplePower 1.0; Borenstein et al., 1997.][15] One of the primary objectives of the study, to evaluate benthic community response along a gradient of total PAH concentration within the contaminated area justifies the unbalanced design for comparing contaminated with reference areas, particularly with the increased sample size. In summary, it is preferable to have more samples from the contaminated area than it is to have a balanced design, given that cost and logistics place constraints on the total number of samples that can be taken and analyzed.

4.2.2.3.2 Benthic Community Evaluation Protocol

The incorporation of benthic invertebrate community data into a Triad evaluation provides an *in situ* evaluation of toxicity. Benthic invertebrates are ideal bioindicators because: 1) they are abundant across a broad array of sediment types, 2) they are relatively sedentary, completing most or all of their life cycle in the same microhabitat, 3) they respond to the cumulative effects of various stressors having differing magnitudes and periods of exposure, and 4) they integrate both the effects of stressors and the population compensatory mechanisms evolved over time to survive in a highly variable and stressful environment.

The natural variability of environmental factors that determine the structure of benthic community data may also limit the use of benthic community studies in assessing effects due to the presence of contaminants. Since the distribution of benthic organisms is generally patchy, reflecting microhabitat differences such as substrate type, water velocity, and depth as well as the effects of biological factors, i.e. predation, competition and reproductive strategies, it is critical that a study design carefully consider these variables. Clearly defining these microhabitat characteristics and avoiding comparisons between communities occurring in dissimilar habitats reduces data variability and improves the confidence in conclusions drawn from benthic

[15] The test of the significance of an increase in R^2 is a test of the null hypothesis that there is no trend in the community parameter as a function of total PAH concentration (i.e., the slope of the regression = 0); rejection of the null requires acceptance of the alternative that there is a trend, that the community parameter changes with total PAH concentration.

community data (Schwenneker and Hellenthal 1984; Mason et al. 1983; Chutter and Noble 1966).

As discussed in Section 4.2.2.3.1, the number and spatial distribution of Triad stations has been expanded to better account for confounding variables such as substrate grain size, the presence of wood waste, the presence of contaminants, water depth, etc. Incorporating these variables into the Triad sampling design will improve the reliability and increase confidence in conclusions drawn from the benthic community data. This will reduce the uncertainty in the interpretation of the study results and result in a more reliable line of evidence for the benthic invertebrate component of the Triad.

Benthic invertebrate community samples will be collected from the locations identified on Figure 13. As indicated, the locations of these stations is tentative and will be finalized after a reconnaissance study. Benthic invertebrate community sampling and laboratory processing methodology is described in detail in SOP 240 in the FSP.

Benthic community data will be analyzed using a number of statistical methods. In addition to use of hypothesis testing using GLM methods discussed above in Section 4.2.2.3.1.3, ANOVA and ANCOVA, other analytical techniques will be employed to evaluate the effect of the contaminants in the sediment AC on the structure of the benthic community. Hierarchical cluster analysis (e.g., unweighted pair-group method using averaging [UPGMA]), using any of several benthic community metrics, may shed valuable insight on heterogeneity of effects. Ordination (e.g., detrended correspondence analysis, canonical community ordination) may be effective in ordering benthic invertebrate species as well as other community characteristics along gradients of total PAH concentration or other variables, such as substrate texture, and reveal interactions among environmental variables. Nonparametric smoothing (e.g., locally weighted scatterplot smoothing [LOWESS]) may reveal nonlinear and threshold responses of the benthic organisms to both differences in contaminant concentrations as well as to other environmental variables.

The results from this study also will be qualitatively compared to the results of other Lake Superior benthic macroinvertebrate community studies to determine whether there are major differences in various benthic community attributes including:

- Total taxa richness;

- Total chironomid richness;
- Total density;
- Chironomid density;
- Oligochaete density; and
- Relative species abundance.

4.2.2.3.3 Sediment Toxicity Testing Protocol

Xcel Energy believes that the results of the 28 day *Hyalella azteca* sediment toxicity bioassays conducted in 2001 indicate a PRG for sediment of between 100 and 300 ppm total PAHs can be supported. However, because of the controversy over interpretation of the results, it is probably more cost effective to conduct another round of bioassays using *Chironomous tentans* as recommended by SEH.

Conduct of another sediment bioassay will also allow the new bioassay stations to be co-located with the benthic community stations that are planned for this phase of the risk assessment studies (Section 4.2.2.3.1). The alternative of not conducting a new sediment bioassay would require that at least some benthic community stations for this phase of the study occupy the 2001 bioassay stations (SEH 2002), to minimize any uncertainty introduced by spatial variability. Regardless, there would be uncertainty resulting from potential temporal variability.

Xcel Energy does not, however, propose to conduct the 28-day *C. tentans* bioassay under ultraviolet (UV) light. Xcel has made this decision for the following reasons:

- The potential effect of UV light on benthic biota is an area of active research and there is debate over its importance in the actual environment, particularly in a near shore dynamic environment like the study site;

- It is nearly impossible to replicate in the laboratory the complex conditions and resulting UV regime experienced by benthic receptors in this environment, so the results are not representative of the real world; and

- Endemic benthic receptors in the Bay sediment are primarily infauna and would not be exposed for any extended periods to UV light.

Xcel Energy also does not propose to conduct any sediment bioassays with larval fish. Xcel Energy has made this decision because it is not aware of any standardized sediment bioassay using larval fish, thus this study is more in the nature of research. While sediment-water interface tests have been designed to look at effects on epibenthic species (such as fish larvae) as a result of contaminant flux from the sediment surface to overlying waters, it would be very difficult to establish conditions in the laboratory that would replicate real world conditions. Thus, there would be substantial uncertainty in applying the results of this type of test to risk management decisions. While these results may be able to document that under current conditions there are potential impacts from some areas of the sediment, Xcel Energy does not contest this fact. Because of the high uncertainty associated with such a larval fish sediment bioassay, the results would not be particularly useful in supporting a sediment remediation goal.

28-day *Chironomous tentans* bioassay

One sediment sample from the top 10cm of the sediment column will be collected from each of the eight benthic sampling locations in the sediment AC and from each of the three reference station areas. Sediment will be collected and handled as described in detail in SOP 240 in the FSP.

Sediment toxicity testing will consist of chronic, 28-day exposures using the midge *Chironomus tentans* test organism according to USEPA Method 100.5. *C. tentans* is an appropriate test organism because it normally completes its life cycle in a relatively short period of time (25 to 30 days) and a variety of developmental and reproductive endpoints can be monitored (USEPA 2000b). Survival and growth endpoints will be measured and used for comparisons between reference and study sites. Quantitative comparisons between sediment toxicity endpoints will be conducted using ANOVA as well as other tests for comparison of treatment group endpoints.

4.2.2.3.4 Sediment and Sediment Pore Water Chemistry Characterization

The sediment chemistry task will consist of collecting bulk sediment for chemical analysis at stations where sediment toxicity and benthic macroinvertebrate samples are collected. Bulk sediment samples from all of the replicates samples will be analyzed for sediment chemistry (one replicate for PAH forensics). One sample from each station will be analyzed for pore water chemistry (SOP 300).

4.2.2.3.4.1 Supplementary Sediment Samples

Sediment and sediment pore water collected at stations where sediment toxicity and benthic samples are collected will be analyzed for VOCs, SVOCs and metals. In addition AVS: SEM analysis will be conducted on one of these samples.[16]

4.2.2.3.4.2 Selection of Samples for PAH Forensics

Forensic PAH analysis will be conducted on one sediment sample from each station where sediment toxicity and benthic macroinvertebrate samples are collected. Xcel Energy's rationale for conducting forensic analysis of PAHs is to be able to evaluate the bioavailability characteristics of PAH compounds in the sediment. For instance, it is known that in an organic sediment milieu, higher molecular weight PAHs are less bioavailable. In addition, soot-phase black carbon (soot) will be analyzed from each of these samples. As observed by McGroddy et. al. (1996), PAHs associated with pyrogenically-derived soot particles may not desorb as readily as those from organic carbon and thus may not be as bioavailable. Sediments will be analyzed for the soot phase carbon using methods discussed in Gustafsson et al. (1997) as improved by Gelinas, et al. http://boto.ocean.washington.edu/aog/soot.htm.

4.2.2.4 Tissue Sampling

4.2.2.4.1 Fish

Xcel Energy proposes to implement the Work Plan developed by SEH for collection of fish tissue for supporting a baseline human health and ecological risk assessment. However, Xcel Energy does not believe that these data can be used for determining sediment remediation goals whether considering direct exposure or exposure through the food chain. These fish species are mobile and there is no way of determining their history prior to being caught. Use of these fish tissue data can only answer the question of whether humans and wildlife ingesting fish from this area have an elevated risk over that resulting from ingesting fish from other locations. However, because of the time-and space-varying exposure history of each fish the data cannot be used to differentiate among various potential sediment remediation goals.

[16] AVS:SEM analysis is an addition to the analytical program listed on Table 1

Fish tissue samples will be collected from the locations identified in Chequamegon Bay selected after discussion with WDNR fisheries staff. Sampling and laboratory processing methodology are similar to those proposed by SEH (2003) and are described in detail in SOP 230 of the FSP.

4.2.2.4.2 Invertebrate

Xcel Energy does not propose to conduct bioaccumulation monitoring with mussels under existing conditions at the site for the following reasons.

- Regardless of where mussels are placed in the Bay area, it is likely that any uptake of contaminants by the mussels is the result of the most heavily impacted areas of the Bay, namely those areas that will eventually be remediated;

- Regardless of the magnitude of uptake of contaminants by the mussels the results of this study would not be useful in determining sediment cleanup levels whether considering direct exposure or exposure through the food chain; and,

- Use of mussel tissue burdens to support food chain models for wildlife is unrealistic. The mussels used in these studies are not endemic to the area and the conditions under which the test is conducted are not reflective of a mussel's niche. Therefore, it does not provide a good basis for a baseline risk assessment.

Xcel Energy believes that having data on invertebrate tissue burdens would have limited usefulness in supporting food web models. The only wildlife receptors that would feed directly on infauna such as mussels would be diving ducks. Xcel Energy believes that this pathway can be modeled using literature based biota-sediment accumulations factors or alternatively by collection of endemic organisms. For other wildlife receptors tissue burdens for fish (See Section 4.2.2.4.1) can be used to evaluate baseline risk conditions. Fish that would potentially prey on mussels or other invertebrates in the area would be assumed to integrate any lower trophic level exposure to contaminants in invertebrate tissue.

4.2.2.5 Sediment Stability Studies

4.2.2.5.1 Introduction

This work plan has been developed to evaluate sediment stability in the sediment AC at the Ashland Lakefront Site. The objective of this proposed study is to determine the potential for existing sediment to be eroded or buried. If the potential for erosion and deposition are determined to exist, net sediment transport rates to and from the study area will be estimated. The results of the study will also be used to evaluate the potential for contaminated sediments to be re-exposed and transported as well as the rate at which the contaminated sediments are being buried due to natural sediment deposition.

The proposed work plan will employ both quantitative (i.e. modeling) and empirical techniques to determine sediment stability as recommended by USEPA (2002). Both of these approaches will be implemented in a screening level phase, and if the results of the screening level analysis indicate further investigation is warranted, a detailed analysis will be performed. Although the two approaches may involve different methods, they will be used jointly to draw conclusions about sediment stability at the Site. The general work plan is broken into a number of tasks:

Task 1: Screening Level Quantitative Analysis
Task 2: Screening Level Qualitative Analysis
Task 3: Screening Level Conclusions and Recommendations
Task 4: Subsequent Hydrodynamic and Sediment Transport Analysis

The work will be completed in a logical sequence in which the start of a subsequent task will not begin until warranted by the results of the previous task. For instance, if the results of the quantitative analysis (Task 1) indicate that the sediments will not be eroded by either local waves and currents nor prop wash, then it will be concluded that the sediments are stable and no further analysis will be conducted. However, if there is a potential for erosion, then the subsequent analysis will be necessary conduct subsequent studies to describe the characteristics of sediment mobility and potential for transport away from the site.

4.2.2.5.2 Task 1.0: Screening Level Quantitative Analysis

The screening level quantitative approach consists of estimating the potential for erosion of existing sediments using quantitative models of erosion and deposition. This approach includes estimation of the hydrodynamic forcing (i.e. currents, waves, depths), the transformation of these forces into bottom stresses (via hydrodynamic models) and the determination of sediment erosion characteristics (e.g., grain sizes, unit weight, erosion parameters). A comparison of the model estimated bottom stresses to the erosion characteristics will result in an estimate of the potential for erosion and erosion rates. The steps for screening level quantitative analysis are described in this section.

4.2.2.5.2.1 Evaluating Current Wave Conditions

The sediment AC is in relatively shallow water and sheltered by jetties and marina structures that may limit both wave propagation and circulation. However, seiches, waves generated by winds from the northeast and storm-generated currents, potentially could provide hydrodynamic forcing to erode the sediments in the site area.

To develop model inputs, a literature search will be conducted. The necessary information on measurements of waves and currents at the Site and in adjacent areas will be identified. Wind wave activity or boat-generated waves may cause disturbance and turbulence in the water column in the vicinity of the site. In somewhat attenuated form, this disturbance may reach the bay bottom where the sediments of concern are deposited. The magnitude of this hydrodynamic disturbance will be quantified in terms of wave heights, wave forces, and velocities of water near the bottom of the bay.

The longest unobstructed direction of over-water winds and wind waves likely to reach the Ashland Lakefront Site is from the northeast. Severe wind speeds in the site vicinity used for this analysis will be obtained from historic data and national standards and guidelines for design wind speeds. The fetch in the north-east direction will be estimated from available maps of Lake Superior. The information on historic high wind speeds in the site vicinity, fetch, and average water depth along the direction of the fetch will be used to estimate significant wave height, wave period, energy dissipated by waves, wave celerities, and critical bottom shear stress. This analysis will be based on empirical charts and US Army Corps of Engineers methods (Limerinos and Smith 1975; USACE 1984). Analytical and empirical equations published by the U.S. Army Coastal Engineering

Research Center will be used to estimate the maximum horizontal water velocity and the average bottom mass transport velocity generated by these waves (USACE 1984).

The hydrodynamic forces associated with boat-generated waves will also be considered. Assuming a relatively large size boat, relatively high boat speed, and critical draft, the maximum expected wave height will be estimated using published empirical equations (e.g., Bhowmik 1975). The corresponding wave energy dissipated on the shore line and the resulting erosion will be estimated using empirical relationships (e.g., Limerinos and Smith 1975). If it is found that there is no potential for sediment movement during a severe wind or boat-generated wave activity, then analysis for sediment movement during normal wind wave conditions and normal boat-generated waves may not be required.

Large water bodies, such as Lake Superior, are characterized by circulation and currents along the shoreline. These currents may cause movement of the sediments deposited in the sediment AC. Available data on current speeds for the Great Lakes and other water bodies will be screened to estimate a reasonable current speed for this screening level analysis.

Overland flow and stream flows entering the bay in the vicinity of the sediment AC may cause disturbance of deposited sediments. To evaluate sediment stability, the volume of inflow during a severe storm event will be considered. In addition to overland flow, there are streams discharging into the bay in the vicinity of Ashland, Wisconsin (e.g., White River, Pine Creek, and some other unnamed tributaries). Since the outfalls of these tributary streams are not centered at one location, potential disturbance associated with the largest and closest stream will be evaluated. Peak flow of the stream will be estimated using USGS regression equations for Wisconsin (USGS 1994) or from stream flow data, if available. Conservative values of entrance velocities may be estimated using Manning's formula and other empirical equations (USDA 1986). This will involve estimation of the drainage areas and stream slopes from USGS topographic maps. A conservative momentum balance approximation or empirical plume entrainment equations (Fischer et al. 1979) may be used to estimate the reduction in velocity as the plume moves farther from the shoreline. Alternatively, the zone of influence of inflow velocities may be conservatively estimated by judgment based on visual observations.

4.2.2.5.2.2 Evaluating Sediment Erosion Characteristics

Data on sediment characteristics required for the quantitative approach depend on whether the sediments exhibit cohesive behavior. Existing grain-size data will be analyzed to determine if the sediments in a particular area within the sediment AC are predominantly cohesive or non-cohesive. Cohesive material may be defined as sediments with d_{50} <0.25 mm and silt/clay content >15% (Ziegler and Nisbet 1994). The silt and clay materials will be indicated by the presence of particles less than 0.062 mm in size. For non-cohesive sediments, which are generally in the medium silt to sand size range, site-specific grain size curves, mineralogy and bulk density will be combined with well-established data from numerous laboratory and field studies of erosion [Shields (Simons and Senturk 1976); Camp (ASCE 1976); Meyer-Peter-Muller (USBR 1984); and Einstein-Strickler-Manning (Simons and Senturk 1976; ASCE 1993; Einstein 1950; Singh 1967)] to characterize their parameters.

However, a review of existing data available in previous risk assessments (SEH 1998; 2002) indicates that cohesive characteristics may occur. The erosion characteristics of cohesive sediments are very site-specific, and there is little guidance available in the literature for developing the characteristics from bulk sediment properties. The best method to characterize the erosion potential of site sediments is to use laboratory testing of site sediment samples or in-situ erosion testing. The tests will provide the critical bottom stress needed to cause erosion, and the rate of erosion for a range bottom stresses above the critical stress.

The presence of wood chips also may alter the erosion characteristics of the sediments and create conditions that are unlikely to have been studied previously. Therefore a diligent effort to obtain site-specific estimates will be made.

Approximately 5 cores will be collected in the sediment AC for use in erosion testing. The cores locations will be distributed across the offshore site to cover possible variations in sediment characteristics and related erosion properties. These locations will be selected after the reconnaissance study described in Section 4.2.2.3. The cores will be collected, packaged and shipped as described in SOP 140 to a designated laboratory for erosion testing. Erosion testing will be conducted in a SEDFLUME or similar device following the protocol described in McNeil et al (1997).

4.2.2.5.2.3 Scenario Development and Erosion Modeling Analysis

In addition to conducting erosion testing in the laboratory, a processed-based model such as one by Glenn and Grant (1987), Madison (1999) and Ziegler (Ziegler 2002; Ziegler et al. 1994; Ziegler et al. 1999) will be implemented evaluate the potential for erosion. Recent modifications to these approaches have been developed to account for bedform (ripples, sand waves etc.) evolution and migration and their effect on hydrodynamic response and sediment transport. These models will be applied with two objectives. First, they will be used to estimate bottom stresses associated with the wave and current conditions found to exist at the site. These bottom stresses will be compared to the critical stresses needed for erosion (i.e. that were determined by the erosion testing of site-specific sediment samples). If erosion is estimated to occur, the models will also be used to estimate the erosion rate associated with the range of wave and current conditions that occur at the site. In this mode both the wave and current parameters and the erosion characteristics will be used in the model.

For sediment stability analysis it is necessary to consider the full range of forcing events that may lead to erosion. A single hydrodynamic event may produce a small amount of erosion and transport, but when many events are integrated over extended time periods, they could also potentially lead to significant changes. Thus a statistical representation of forcing conditions for the area will be developed and the erosion analysis will be conducted for a range of conditions. The results will be combined to estimate the long-term potential for erosion.

The models will be configured to represent wave and current conditions developed from the analysis of forcing conditions in the preceding task and input files representing the forcing functions and sediment characteristics will be developed. The models will be used to simulate the scenario conditions and the results evaluated to determine the potential for erosion. If significant erosion is estimated, an estimate of advective potential contaminant flux from the bed will be made by incorporating the erosion results with previous chemical analysis of the sediments. Advective contaminant fluxes will be estimated using the same process-based models. The computed erosional fluxes will be multiplied with measured sediment contaminant concentrations to provide the contaminant flux. The results will be provided for a range of forcing conditions (i.e. waves and currents) representative of historical conditions at the site and used to develop an estimate of potential contaminant transport.

Additionally, an empirical approach for assessing sediment stability will be used. Empirical charts are available for permissible unit tractive stress for cohesive material with different degrees of compaction and different types of cohesive materials (e.g., lean clay, clay, heavy clay, and sandy clay) and for different types of non-cohesive materials (e.g., loam, silt, sand, and gravel) (Chow, 1959). These charts will be used to compare the expected shear stresses for the aforementioned hydrodynamic conditions with permissible values for non-scouring conditions.

4.2.2.5.2.4 Boat Propeller Wash Scour Analysis

In addition to evaluating the stresses along the shore line and in shallow depths from boat waves as discussed above, the potential for prop wash induced scour also will be evaluated. A preliminary screening level implementation of the JETWSH model (Pacific International Engineering, PLLC 2000, 2001) combined with desktop analysis will be applied to calculate the velocities generated by a propeller and the maximum time-averaged near-bottom velocities at specified distances from the propeller.

Estimates of the required vessel and propulsion parameters, including vessel length, draft, depth to center of propeller, number, type, and diameter of propellers, propeller speed (RPM), power applied to propellers (kilowatt), thrust (lbs or HP) and angle of shaft will be made for each type vessel type expected to operate in the vicinity of the cite. The output from the JETWSH model for individual vessels will be used to estimate related hydrodynamic bottom stresses to be used in the calculation of erosion rates. These results will be combined with vessel traffic projections to estimate the potential for prop wash induced scour at the site.

The results of these analyses will be used to estimate the amount of erosion that may occur due to boat prop washed induced scour and also to provide guidelines for limiting boat traffic and speeds.

4.2.2.5.3 Task 2.0: Screening Level Empirical (Qualitative) Approach Work Plan

The empirical analysis will develop a conceptual model that best characterizes sediment stability at the site. The conceptual model developed as part of this empirical analysis will attempt to describe the historical development of the existing contaminated sediments by considering various possible sediment and contaminant transport mechanisms and pathways. It may also be used to estimate historic site-specific transport rates and provide a basis for estimating future rates of sediment erosion and deposition. The empirical study will provide insight into the site-specific sediment transport processes and yield bounds that can be used to constrain and guide the quantitative analysis

Review of existing data indicates that contamination in the Ashland sediments is mainly confined to a sediment layer extending a few hundred feet from the shoreline. The layer has a maximum thickness near the shoreline, typically 3 to 4 feet, and tapers off in the offshore direction. The layer is characterized by the presence of wood chips and most of the contamination is confined to this layer, although some contamination appears to exist just below the wood chip layer. The wood chips apparently were derived from local material, either from the sawmill or directly from logs floated and rafted into the Ashland area.

Based upon a review of existing data, there are at least two possible conceptual models that explain the current contaminant distribution at the Site contamination. These models are preliminary, but serve as a starting point for the empirical analysis. Two alternate conceptual models are described below, and the tasks necessary to further evaluate the models are provided.

In the first conceptual model, it is noted that much of the existing shoreline and some of the marina structures were created by back-filling soil into the bay. It is possible that the process of back-filling, which is assumed to have occurred episodically between 120 and 60 years ago, created most of the contaminated wood-chip laden sediment layer. The backfill material, which was likely generated from the bluff and surrounding area, contained wood processing wastes as well as contamination from facilities operating in the area. Xcel Energy has produced documentation that it believes indicates the PAH contamination measured in the sediments has been generated from multiple sources (e.g., wood treatment and operations at the former Schroeder Lumber Company, as well as discharge from the former manufactured gas plant, and off-loading of petroleum-based materials at railroad sidings).[17] As this material was transported to the harbor, some of it escaped into the surface water and settled out in the near shore area. The shape of the wood-chip layer, thick near the shoreline and tapering offshore, is consistent with this view.

In this interpretation, most of the contamination was derived from existing soil and surface contamination associated with the back-fill material. It is also possible that sediments associated

[17] Although operation of the former WWTP may have contributed to sediment disturbance, the municipal sanitary discharge from the WWTP did not likely contribute to PAH contamination in AC 4.

with surface runoff and groundwater transport contributed to the development of the deposit. Both contaminated and uncontaminated sediments reached the Site from rainfall induced surface runoff originating in the watershed adjacent to the Site. It is alternatively possible that contaminated surface runoff mixed with re-suspended sediments and contributed to the contaminated sediment layer as it evolved. However, it is likely that these processes only played a secondary role relative to the contamination derived from the back-filling.

An alternate conceptual model for the evolution of the contaminated sediment layer is based on regional sediment transport patterns. In this interpretation, much of the sediment that comprises the layer may have originated up and down shore of the Site. Sediment was (and possibly still is) transported via waves and currents all along the shoreline and during high energy events and the sediment that makes its way into the Site will deposit during the waning phase of the event. Although the sediment may have been contaminant-free at its origin, it likely mixed with contaminated runoff and/or contaminated sediments from the watershed adjacent to the Site, and then deposited at the Site.

It is known that logging was active during the last 120 years in the region. Logging could have provided a steady source of sediment to the harbor area since logging activities are known to increase soil erosion and provide additional source of sediments to rivers. A review of stream and river networks in the area show two drainage basins, one to the east and a larger one to the west. These rivers may have carried relatively large sediment loads to Chequamegon Bay, some of which eventually were deposited at the Site. It is likely that the current sediment load has been reduced relative to loads that occurred during the period of relatively uncontrolled historic logging activities, due either to reduced logging activities and/or improvement in logging procedures.

In this conceptual model, the evolution of the contaminated sediment layer occurred fairly continuously, due primarily to the sediment loads associated with the regional logging industry. In a large-scale long-term view, for the period of 120 to 60 years ago, the Bay was unable to flush the anthropogenic source of sediments at the rate that they were supplied. The hydrodynamic forces may have been able to remove some of the additional load to deeper water but not all of it. Thus the sediments began to accumulate along the shoreline as well as in deeper waters in the Bay. In terms of sediment balance, there was net sediment input into the Bay.

The work plan for the empirical analysis consists of further development of these models, additional review and analysis of existing data, inclusion of other data sources and results from the proposed additional data collection, as well as considering alternate hypotheses individually or in combination.

4.2.2.5.3.1 Data and Literature Search

Additional existing data that could be helpful for understanding which conceptual model is more representative for the sediment AC are USGS river flow and sediment load data, either from adjacent watersheds or nearby watersheds, historic and current land use maps, detailed operational data for the Site and adjacent areas (including regional logging practices), meteorological data, and oceanographic data for Chequamegon Bay.

The empirical analysis will also rely on analysis of existing data such as the sediment borings, vertical profiles of contamination, sediment deposition rates, physical sediment characteristics as well as other Site data on land use characteristics, regional hydrography, river sediment loading rates, and contaminant behavior in sediment, soils and water.

These data will be acquired, compiled and reviewed to provide a basis for evaluating the alternate conceptual models. They will also be used to guide the design of additional data collection programs.

4.2.2.5.3.2 Additional Field Sampling and Analysis

Based upon the results of Task 1 and the results of the data review effort it may be necessary to collect additional data to help quantify and verify or refute the conceptual models. If this is necessary a sampling plan for additional borings and cores will be developed for USEPA review. This work will consist of collecting sediment and soil samples for bore logging, grain size analysis, age dating and chemical analysis. It is expected that two onshore borings and up to 4 offshore cores will be required. The soil borings will be taken just inland of the shoreline will be analyzed for some of the same characteristics that are found in the sediment AC.

For instance, if a wood-chip-laden layer is also present in the soil borings at elevations consistent with the offshore borings, then it is evidence that the contaminated layer was created predominantly by back-filling activities. Additionally, higher resolution vertically-stratified profiles of key contaminants and or grain size in a few select sediment cores could provide additional information for evaluating historic and current transport processes and rates.

On the other hand, if analysis of the inland soil borings do not provide sufficient information, it may be necessary to conduct age dating (most likely Pb_{210}) of the offshore cores to help quantify depositional rates. The age dating profiles from sediment borings could have one or two characters, either ages fairly uniform throughout the layer, which indicates that back-filling may be the dominant process or they may indicate a more gradual development, consistent with the regional sediment transport interpretation. Similar conclusions can be drawn from the structure of high-resolution (i.e. 2 cm) vertically-stratified profiles of contaminants in key sediment cores.

4.2.2.5.3.3 Summary of Qualitative Analysis

The results of the data review, data analysis and subsequent field sampling and analysis will be documented in a report. The report will describe the analysis result, and revise the site conceptual model to incorporate the characteristics and dynamics of sediment stability and mobility.

4.2.2.5.4 Task 3.0: Screening Level Analysis Conclusions and Recommendations

At the conclusion of the screening level phase, results from the quantitative and empirical approaches will be combined in a report to make an assessment of sediment stability at the Site. If necessary, recommendations for subsequent field work and analysis will be discussed.

4.2.2.5.5 Task 4.0: Subsequent Hydrodynamic and Sediment Transport Analysis

If the screening level analysis does not produce conclusive estimates of the sediment stability, an additional phase will be conducted which will be based on hydrodynamic and sediment transport modeling. The model will be used to estimate sediment deposition and erosion in and around the Site. This analysis will involve additional data collection for model calibration and forcing. The model will be either a 2 or 3D numerical model, consistent with the US Army Corp of Engineers Surface Water Modeling System ADCIRC and M2D models or SED2D and SEDZL models (Ziegler et al. 1994; Ziegler 2002).

This analysis will involve additional data collection for model calibration and forcing. The data collection and modeling plan will be developed at the time the detailed modeling is determined necessary (i.e., at the end of the screening level phase). Data and information obtained in the screening level phase, from both the quantitative and empirical analysis, will be used to guide the development of the data collection and modeling phase.

4.2.2.6 Baseline Ecological Risk Assessment

A Baseline Ecological Risk Assessment (BERA) will be conducted to evaluate the potential for adverse effects to ecological receptors from COCs in Bay sediment using the assessment endpoints outlined in Table 4-2. Throughout the process of preparing the BERA, additional objectives reflecting the relevant Principles for Managing Contaminated Sediment Risks at Hazardous Waste Sites (OSWER 2002) will also be addressed.

The BERA will be prepared in accordance with ERAGS (USEPA 1997) and will comply with Steps 3 (Baseline Risk Assessment Problem Formulation) and Step 7 (Risk Characterization) of the 8-step risk assessment process. Step 4 (Study Design and Data Quality Objective Process), Step 5 (Field Verification of Sampling Design) and Step 6 (Site Investigation) are considered to be part of this work plan. Additional guidance that may be consulted in preparation of the BERA includes the following:

- Guidance for Ecological Risk Assessment (USEPA 1998);
- DRAFT *Planning for Ecological Risk Assessment*: Developing Management Objectives (USEPA 2001):
- Guidance for the Data Quality Objective Process (USEPA 2000);
- Principles for Managing Contaminated Sediment Risks at Hazardous Waste Sites. OSWER Directive 9285.6-08; and,
- DRAFT Contaminated Sediment Remediation Guidance for Hazardous Waste Sites. OSWER 9355.0-85 (USEPA 2002).

Results of the BERA are intended to be used by risk managers in recommending remedial activities that represent a clear and transparent relationship between proposed remedial action outcomes and proposed risk management goals.

The following sections describe the development of the Problem Formulation (Step 3) and the Risk Characterization (Step 7).

4.2.2.6.1 Baseline Problem Formulation – Step 3 (ERAGS)

The BERA will be initiated by updating Step 3 (Baseline Problem Formulation) in the BERA process. The BERA Problem Formulation will be revised to reflect the additional information resulting from the studies described in this work plan.

The following sections present Xcel Energy's proposals for risk management goals and objectives, assessment endpoints, measurement endpoints, critical exposure pathways to evaluate, receptors of concern and risk hypotheses that will be used as the basis for revision of the BERA Problem Formulation. A "Straw Man Baseline Problem Formulation" was developed by Xcel Energy (URS 2003) to describe how Xcel Energy believes ERAGS should be synthesized with recent USEPA strategy and guidance at contaminated sediment sites and some of the approach presented in that document is reflected in the following discussion.

4.2.2.6.1.1 Nature and Extent of Contamination

The nature and extent of contamination has been investigated during numerous previous studies. These previous studies identified contamination in Kreher Park and in near shore bay sediments. COCs identified during previous investigations of the sediments include metals, VOCs, and SVOCs. The focus of the BERA will be to integrate the Triad data to further define the nature and extent of contamination from COCs and attempt to relate COCs, if they are unique, to historical sources.

4.2.2.6.1.1.1 Refinement of Constituents of Potential Concern

Since there have been two ecological risk assessments prepared historically (SEH 1998a; SEH 2002), the refinement step will be eliminated in this Baseline Problem Formulation. Chemicals that have been identified as contaminants in these earlier risk assessments will be the presumptive list for the BERA. As such, the COCs of the BERA are semi-volatile organic constituents (SVOCs) including benzo(a)pyrene, benzo(a)anthracene, xylenes, ethylbenzene, VOCs, cyanide, copper, lead, mercury, and zinc.

4.2.2.6.1.1.2 Other Factors of Potential Ecological Concern

In addition to contaminants that are related to past industrial operations on the site, there are several other factors, resulting from various historical operations near the Ashland site. These can cause conditions which may have some of the same effects as contaminants on habitat characteristics and thus on the receptors being evaluated in the BERA. These factors will be qualitatively assessed for their potential to pose a risk to wildlife given that the physical disturbances caused by these stressors may limit the degree of habitat recovery that would occur following any remediation. Further, studies developed to collect data necessary to support the BERA should take into consideration that the selected reference areas have the potential to help differentiate impacts caused by Ashland site contaminants from impacts due to other Ashland site stressors.

The following is a preliminary list of activities not directly related to MGP activities that will be generally addressed in the BERA:

1) Publicly-owned parcels of the lakefront were created during the late 1880s to the early 1900s by the uncontrolled placement of wood wastes, soil, sand, and demolition waste material into Chequamegon Bay;
2) Sawdust and wood waste from a series of sawmills that operated on the Ashland site from the early 1880s until about the mid-1930s were dispersed by natural forces, rain, flooding, storms and ice throughout Chequamegon Bay;
3) Log rafting and timber loading led to bark and wood waste accumulating to depths of many feet in various places in Chequamegon Bay;
4) Releases from wood treatment operations;
5) Discharges from the former WWTP; and
7) Indirect effects on structural habitat, nutrient cycling and other physical changes related to water level and sediment deposition.

4.2.2.6.1.2 Rick Management Goal and Management Objectives

As defined by USEPA (2001):

"A *risk management goal* is a general statement of the desired condition or direction of preference for the entity to be protected. It is often developed independently of the risk assessment process. [….], *management objectives*, while similar to management goals, differ in that they should be specific enough to use when developing assessment endpoints and measures."

The following risk management goal will be used in the BERA:

"Reduce to acceptable levels the risks to human health and the environment that may result from site-related contamination in the sediments at Ashland."

More specific risk management objectives were also identified to define how the management goal will be achieved and provide a basis for later risk management decisions (USEPA 2001). The proposed management objectives that follow from this management goal are:

- Restore surface sediment quality so that it can support viable and self-sustaining populations of benthic macroinvertebrates and fish. This includes four corollary management objectives:
    - Reduce levels of contaminants in surface sediment to a level that is compatible with supporting a diverse self-sustaining benthic macroinvertebrate community.
    - Ensure contaminants in subsurface sediments are not transported to the sediment surface or water column, though diffusion, bioturbation, interstitial advection, erosion, resuspension or other transport mechanisms in quantities sufficient to jeopardize the sustainability of benthic macroinvertebrate and fish populations at Ashland and adjacent areas.
    - Ensure that the populations of birds and mammals that depend upon aquatic prey are not impacted from ingesting site-related chemicals in fish and invertebrates inhabiting the Bay sediment to the extent that it will jeopardize the sustainability of these species' populations.
    - Ensure protection of special status species by protecting individual representatives of these species from unacceptable acute and chronic exposures to site-related chemicals originating from the Bay sediments.

These proposed management goals and objectives follow after a consideration of many potential management goals and objectives. Xcel Energy believes that these are the key management objectives for the Bay sediments. While this list of management objectives could be more extensive, the achievement of these management objectives will ensure other biotic communities' environmental values are protected.

4.2.2.6.1.3 Assessment Endpoints

An assessment endpoint, according to USEPA (1997) is:

"An explicit expression of the environmental value [or ecological entity (USEPA 1998)] that is to be protected."

Assessment endpoints were selected since they are closely related to the management objectives developed in Section 4.2.2.6.1.2. For specific assessment endpoints, risk hypotheses are evaluated using measures of exposure, effects, and ecosystem characteristics. The following sections present the assessment endpoints selected for use in the BERA.

Aquatic Receptors

- Survival, growth, and reproduction of benthic macroinvertebrate communities in the affected areas at the Ashland site.
- Survival, growth, and reproduction of fish communities in the affected areas of the Ashland site.

Terrestrial Aquatic Prey-Dependent Receptors

- Survival, growth, and reproduction of aquatic-dependent wildlife in habitats bordering the Ashland site.

Special Status Species

- Survival and growth of individuals of special status species.

4.2.2.6.2 Ecosystems Potentially at Risk

The BERA will focus on a portion of the aquatic ecosystem of the sediment AC (Figure 13). The boundaries of this "affected habitat" have not yet been well established. It has not been determined whether contaminants associated with the sediments of this portion of the Ashland site are transported in significant quantities beyond that immediate area either through sediment erosion and advective transport or through food chain transfer. Studies conducted as part of the BERA will help answer this question.

4.2.2.6.3 Exposure Pathways

Exposure pathways are routes by which contaminants are transferred from a contaminated medium to ecological receptors. For the Bay sediments, the potential exposure pathways include the following:

- Birds - ingestion of sediment, surface water, and food;
- Mammals - ingestion of sediment, surface water, and food;
- Fish - ingestion and direct contact with sediment and surface water;
- Reptiles and amphibians - ingestion and direct contact with sediment and surface water and ingestion of food;
- Aquatic invertebrates - ingestion and direct contact with sediment or surface water and ingestion of food;
- Aquatic plants - root uptake and direct contact with sediment and surface water; and,
- Phytoplankton and zooplankton – direct contact with surface water.

Some exposure pathways have been combined with others or cannot be quantitatively evaluated because of a lack of available information for the exposure evaluation. These will be considered uncertainties in the BERA. Examples of these potential exposure pathways include dermal and inhalation exposures for birds and mammals. Although these pathways are not quantitatively evaluated they are considered relatively minor exposure pathways relative to other exposure pathways.

The following exposure pathways will not be quantitatively evaluated for the following reasons:

Potential Exposure Pathway	Reason for not Evaluating Quantitatively
Microbial processes: Exposure to chemicals in sediment and surface water.	Inadequate information to quantitatively evaluate.
Benthic and aquatic invertebrates: Exposure to chemicals through food chain transfer.	Inadequate information to quantitatively evaluate. Fish tissue will integrate any food chain transfer at lower trophic levels.
Birds and Mammals: Exposure to chemicals through dermal adsorption.	The fur-covered skin of mammals and the feathers of birds limit the direct dermal uptake of chemicals from the environment; therefore this pathway will not be evaluated. Preening and grooming behaviors, however, contribute to the incidental ingestion of soil or sediment, and are included as part of the incidental ingestion exposure pathway.
Birds and Mammals: Exposure to chemicals through inhalation.	It is doubtful that there is sufficient volatilization of sediment-associated chemicals to result in a threat to bird and mammal receptors. This will be discussed as an uncertainty.

4.2.2.6.4 Receptors of Concern (ROCs)

As part of the Baseline Problem Formulation, receptors at risk within the affected habitat are identified from the conceptual site model. From these species several representative species are selected as receptors of concern (ROCs). These ROCs will be used in the BERA to evaluate the potential for adverse effects and serve as a proxy for other receptors that have similar niches; food habits or feeding behaviors; they are exposed to Ashland site contaminants in a similar manner or have similar sensitivity to Ashland site contaminants. In the affected area of the Ashland site the ROCs include the following:

<u>Microbial communities</u> - This functional group will be considered collectively as a ROC but will not be evaluated quantitatively.

<u>Benthic macroinvertebrate communities</u> - This functional group will be considered collectively as a ROC. The fingernail clam, *Pisidium* sp., the most abundant mollusk found at the site (SEH 1998b), will be considered a ROC because of the potential for mollusks to bioaccumulate PAHs.

<u>Fish</u> –

- black bullhead (*Ictalurus melas*), a bottom feeding species
- walleye (*Stizostedion vitreum*)

Avian Wildlife –

- great blue heron (*Ardea herodias*), a wading bird that feeds primarily on fish and amphibians
- mallard duck (*Anas platyrhynchos)*, which feeds on benthic invertebrates and vegetation
- merlin (F*alco columbarius)*, State-listed species of concern

Mammalian Wildlife - mink (*Mustela vison);* a mammal whose diet includes a high proportion of fish at some times of the year.

4.2.2.6.5 Risk Questions and Risk Hypotheses

Risk questions are questions about the relationship between assessment endpoints and their predicted responses when exposed to contaminants (USEPA 1997). Key risk questions and risk hypotheses proposed for the Bay sediments are summarized in Exhibit 4-2.

Exhibit 4-2 Assessment Endpoints, Risk Questions and Testable Hypotheses.

Assessment Endpoint	Risk Question	Testable Hypotheses
Survival, growth, and reproduction of benthic macroinvertebrate communities.	Are concentrations of contaminants in the Bay sediments sufficiently elevated that they cause adverse effects on benthic macroinvertebrate survival, growth and reproduction?	Sediment contaminant concentrations are not elevated ($p<0.05$) above the no-observable-effects-concentrations (NOEC) or lowest-observable-effects concentrations (LOEC) for benthic biota.
		Sediments of the affected area of the Ashland site do not have elevated ($p<0.05$) toxicity to surrogates for resident macroinvertebrate species compared to sediments in reference areas.
		Benthic communities inhabiting sediments at the Ashland Site are not impaired when compared to benthic communities inhabiting reference area sediment.
Survival, growth, and reproduction of fish communities.	Are concentrations of contaminants in the sediments at the Ashland site sufficiently elevated that they cause adverse effects to fish survival and growth?	Sediment concentrations are not elevated ($p<0.05$) above NOECs or LOECs for fish.
		Sediments at the Ashland site do not have elevated ($p<0.05$) toxicity to surrogates (fathead minnow) for fish species compared to sediments in reference areas.
		Sediment contaminant concentrations are not greater than ($p<0.05$) levels that result in deformities, fin erosion, or other histopathological effects in fish based upon the literature.
		Tissue residues of contaminants are not greater ($p<0.05$) in fish utilizing sediments at the Ashland site than in fish from reference areas.
		Tissue residues of contaminants are not greater ($p<0.05$) in fish utilizing sediments at the Ashland site than critical body residue effects levels as derived from the literature.
Survival, growth, and reproduction of aquatic-dependent wildlife.	Are concentrations of contaminants in the sediments incidentally ingested and the diet of aquatic-dependent wildlife sufficiently elevated that they cause adverse effects to their populations?	Intake of contaminants ingested with prey and incidental sediment is not greater ($p<0.05$) than the no effect dose (NOAEL) or low effect dose (LOAEL) to aquatic-dependent wildlife.
Survival, growth and reproduction of individuals of special status species.	Are concentrations of contaminants in the sediments incidentally ingested and diet of aquatic-dependent wildlife sufficiently elevated that they cause adverse effects to individuals of special status species?	Intake of contaminants in prey and incidental sediment is not greater ($p<0.05$) the NOAEL or LOAEL for aquatic-dependent wildlife.

4.2.2.6.6 Risk Characterization – Step 7 (ERAGS)

The final step in the BERA is the Risk Characterization, which includes risk estimation and risk descriptions. Information collected during the site investigation is used to support qualitative risk evaluations. Quantitative risk evaluation is conducted by comparing estimated exposures with appropriate toxicity values to calculate hazard quotients. Uncertainties are inherent in quantitative assessments. As such, a qualitative discussion about the range of confidence in the risk characterization (i.e., low, medium, high) will be provided including a description of the factors that may contribute to an overestimation or underestimation of risk. If possible, risk will be expressed in terms of relative magnitude and direction (over- or underestimation). The output from the uncertainty analysis will be an evaluation of the impact of the uncertainties on the overall assessment and, to the extent possible, will include mechanisms to reduce uncertainty.

4.2.3 Chequamegon Bay Sediments - Alternative 2 - Problem Formulation Strategy

4.2.3.1 Introduction and Rationale

In accordance with recent discussions with USEPA, Xcel Energy proposes that additional baseline problem formulation efforts be conducted with the active involvement of all potentially affected parties.[18] This effort should be initiated before implementing any further investigations to support an ecological risk assessment and future risk management decisions for the Bay sediments.

Xcel Energy does not believe that a baseline problem formulation as contemplated by USEPA guidance (USEPA 1997) for ecological risk assessment at Superfund sites, or a consultancy process envisioned by the "Principles for Managing Contaminated Sediment Risks at Hazardous Waste Sites" (OSWER Directive 9285.6-08, USEPA 2002), have been completed for the sediment area of concern at the Site. The process of "passive" comment that has occurred at this Site has essentially been one-way communication between the oversight agency to the potential

[18] Xcel Energy does not disagree with the perspective that WDNR presented in its December 30, 2003 memorandum. In this memorandum the WDNR took the position that the Problem Formulation process was underway and needn't be initiated de novo. The memorandum indicated, appropriately, that the Problem Formulation process is intended to be an iterative process, one that is revisited as more information is available. As summarized in this section, Xcel Energy is advocating that the continuation of the Problem Formulation process be a participative one, one in which potentially affected parties play an active role.

responsible parties and stakeholders. It has not been a problem formulation process as described in USEPA's guidance. With the goal of increasing the level of stakeholder and community participation in the risk assessment process, Xcel Energy proposes the following problem formulation process.

4.2.3.1.1 Active Involvement of Potentially Affected Parties in the Problem Formulation Process

The National Research Council (NRC), in its report, "A Risk Management Strategy for PCB-Contaminated Sites" (NRC 2001) recommended that risk management of PCB-contaminated sites[19] should "include early, active and continuous involvement of all affected parties and communities." This recommendation was incorporated as one of the 11 "Principles for Managing Contaminated Sediment Risks at Hazardous Waste Sites" (USEPA 2002) where USEPA cited the NRC report as follows:

"that increased efforts be made to provide the affected parties with the same information that is to be used by the decision-makers and to include, to the extent possible, all affected parties in the <u>entire decision-making process</u> (emphasis added) at a contaminated site. In addition, such information should be made available in such a manner that allows adequate time for evaluation and comment on the information by all parties."

The NRC report (NRC 2001) recommended that the involvement of potentially affected parties go beyond the traditional public relations approach required by CERCLA where potentially affected parties are limited to providing passive feedback on nearly completed draft work plans and what are perceived as nearly finalized decisions. As NRC (2001) summarizes:

"Despite the presence of a concerned public at these sites (the sites upon which this report focused) the committee found that opportunities for public involvement generally had been limited to prescribed times in the cleanup process and that the process (public involvement) was dominated by the PRPs and the agencies with little communication among the affected parties." As a result significant distrust of the process developed and "this distrust led to a gridlock at many sites, with extensive delays or no forthcoming management decision."

Xcel Energy believes that without more active participation by the community and other stakeholders, distrust of the RI/FS process will develop, as indicated by NRC in its 2001 report:

[19] Although this report focused on PCB-contaminated sites, the general results are relevant to all contaminated sediment sites.

"The framework developed by the Presidential/Congressional Commission on Risk Assessment and Risk Management established a critical role for all affected parties by integrating them into the risk management process from the initial problem-definition stage (emphasis added) through all of the remaining stages. Community involvement will be more effective and more satisfactory to the community if the community is able to participate in or directly contribute to the decision-making process. Passive feedback about decisions already made by others is *not* (emphasis in report) what is referred to as community or stakeholder involvement."

Furthermore, Xcel Energy sites the disagreements and contentious comments related to the previous Ecological Risk Assessments performed at this site as the basis for more active involvement in the RI/FS process by the community and other stakeholders. The proposed Problem Formulation process described in this section would encourage the active involvement by the appropriate parties.

4.2.3.1.2 Summary of Baseline Problem Formulation Process

Xcel Energy proposes that we immediately open the Problem Formulation process to the community and other stakeholders to solicit their active input into developing the goals and objectives for both the human health and ecological risk assessment and the scope of the studies that will be conducted to address these goals and objectives. The objectives of having them actively involved in this process would be to:

1) Discuss the overall strategy for conducting the remedial investigation and evaluating remedial options for the Bay sediments;
2) Share technical information on the Bay sediments, including the identity of chemicals of concern, the location of more highly impacted areas, and the ecology and environmental conditions in the study area;
3) Provide an overview of the work that has been completed to date, including the screening level ERA, the Supplemental ERA, and results of the SEH problem formulation process;
4) Present management goals, management objectives and assessment endpoints proposed by Xcel Energy and identify any refinements that are necessary;
5) Present the SEH conceptual site model and identify any refinements that are necessary, including identification of key aquatic and terrestrial receptors utilizing the Bay sediment area;

6) Present measurement endpoints that are proposed by Xcel Energy for use in evaluation of the assessment endpoints and identify any refinements that are necessary;
7) Present the sampling and analysis plan proposed by Xcel Energy and identify any refinements that are necessary; and
8) Reach agreement on how the results of the studies will be interpreted and used along with the results of previous studies to develop risk-based remediation goals for the Bay sediments.

To initiate this process with the potentially affected parties Xcel Energy will present proposals for:

1) A management goal, management objectives, assessment endpoints and measurement endpoints for the ecological risk assessment;
2) A summary of exposure pathways to be evaluated in the human health risk assessment process;
3) Preliminary work scopes for risk assessment and sediment stability studies;
4) A process for discussing and refining work scopes; and
5) A process for deciding how the results of the studies will be interpreted and used to develop remediation goals for the Bay sediments.

The following sections summarize these proposals and also present Xcel Energy's suggestions for how this process will be facilitated, who will participate, and the anticipated schedule. Illustrations of how the outcome of this process may differ from the more approach now being used are also provided.

4.2.3.2 Proposed Problem Formulation Process

4.2.3.2.1 Proposed Management Goals, Objectives and Assessment Endpoints

4.2.3.2.1.1 Risk Management Goal and Management Objectives

As defined by USEPA (2001):

"A *risk management goal* is a general statement of the desired condition or direction of preference for the entity to be protected. It is often developed independently of the risk assessment process. [….], *management objectives*, while similar to management goals, differ in that they should be specific enough to use when developing assessment endpoints and measures." Once broad risk management goals are developed, more specific risk management objectives are identified to define how the management goal is achieved and provide a basis for later risk management decisions (USEPA 2001).

Since many potentially affected parties are involved in decision-making during the remedial investigation process, including the risk assessment and risk management, management goals should be developed as part of a process involving all potentially affect parties. While the risk management goals need to recognize legislative requirements, additional factors such as economic considerations or public values may be integrated into these broad goals to recognize the uniqueness of each site.

The following risk management goal for the affected area at Ashland is proposed:

"Reduce the risk to ecological receptors from sediment contaminants to levels that will result in the recovery and maintenance of healthy local populations and communities of biota."

The proposed management objectives that follow from this management goal are:

- **Restore surface sediment quality so that it can support viable and self-sustaining populations of benthic macroinvertebrates and fish.** This includes four corollary management objectives:

- Reduce levels of contaminants in surface sediment to a level that is compatible with supporting a diverse self-sustaining benthic macroinvertebrate community.

- Ensure contaminants in subsurface sediments are not transported to the sediment surface or water column, though diffusion, bioturbation, interstitial advection, erosion, resuspension or other transport mechanisms in quantities sufficient to jeopardize the sustainability of benthic macroinvertebrate and fish populations at Ashland and adjacent areas.

- Ensure that the populations of birds and mammals that depend upon aquatic prey are not impacted from ingesting site-related chemicals in fish and invertebrates inhabiting the Bay sediment to the extent that it will jeopardize the sustainability of these species' populations.

- Ensure protection of special status species by protecting individual representatives of these species from unacceptable acute and chronic exposures to site-related chemicals originating from the Bay sediments.

These proposed management goals and objectives follow after a consideration of many potential management goals and objectives. Xcel Energy believes that these are the key management objectives for the Bay sediments. While this list of management objectives could be more extensive, the achievement of these management objectives will ensure other biotic communities' environmental values are protected.[20]

4.2.3.2.1.2 Assessment Endpoints

An assessment endpoint, according to USEPA (1997) is "an explicit expression of the environmental value [or ecological entity (USEPA 1998)] that is to be protected." Assessment endpoints should be closely related to the management objectives developed for the site. For specific assessment endpoints, risk hypotheses are evaluated using measures of exposure, effects, and ecosystem characteristics.

[20] Xcel Energy recognizes that these management goals and objectives could change as a result of the involvement of the various stakeholders.

Assessment Endpoints for Aquatic Receptors

The following assessment endpoints are proposed for aquatic receptors:

- Survival, growth, and reproduction of benthic macroinvertebrate communities in the affected areas of the Bay sediments.

- Survival, growth, and reproduction of fish communities in the affected areas of the Bay sediments.

These two assessment endpoints are proposed for use in evaluating the attainment of the proposed management goal and the three management objectives for aquatic receptors. The active participation by the community and other stakeholders may identify additional endpoints.

Assessment Endpoints for Terrestrial Aquatic Prey-Dependent Receptors

Most of the management objectives relate directly to aquatic receptors, however if it is demonstrated that any of the COCs biomagnified there is the potential for adverse effects to populations of aquatic prey-dependent wildlife. The following assessment endpoint is proposed:

- Survival, growth, and reproduction of aquatic-dependent wildlife in habitats bordering the Bay area.

Assessment Endpoints for Special Status Species

The following assessment endpoint is proposed for special status species:

- Survival and growth of individuals of special status species that directly or indirectly utilize the Bay area.

4.2.3.2.2 Measurement Endpoints

In general the measurement endpoints for these studies will include sediment chemistry, results of bioassays conducted with Bay sediments compared to those conducted with sediments from reference areas, the structure of benthic communities in the Bay area compared to reference areas and differences in tissue burdens of site-related contaminants for organisms utilizing the Bay area versus those from reference areas. Specific details of these measurement endpoints and their associated risk hypotheses will be developed as part of the participative Problem Formulation process.

4.2.3.2.3 Proposed Work Plans for Risk Assessment and Sediment Stability Studies

The work plans for risk assessment and sediment stability studies proposed in sections 4.2.2 will serve as the starting point for continuation of the Problem Formulation process. Copies of these proposed work plans will be provided to potentially affected parties.

4.2.3.2.4 The Process for Refining Work Scopes

A comparison of the risk assessment and sediment stability studies that Xcel Energy has proposed and those proposed by SEH indicates that there are several differences in approach and detail of the studies. It is also likely that other individuals and stakeholders in the community, including natural resource trustees, may have a substantial input into defining the environmental issues associated with the Bay sediments.

Xcel Energy believes that the process of refining the work scope will begin with reaching a consensus on the management goals, management objectives, assessment endpoints and the conceptual site model. There will then be an opportunity for all potentially affected parties to participate in the development of the final risk management goals and objectives, and ultimately the proposed work scope presented by Xcel Energy. It is envisioned that this process will be facilitated and agreement on work scopes will be reached by consensus or by delegating areas of controversy to work groups, technical or otherwise, that represent the various potentially affected parties. As shown on the project timeline in Section 6.0, it is proposed that by scheduling two separate workshops those areas of controversy can be identified in the first workshop leaving time before the end of the second workshop to resolve any differences.

It is expected, as with any process involving multiple affected parties, that there will be occasions during the process where the risk manager at USEPA may have to resolve disagreements. It will be advantageous to agree upon a "transparent" and objective process for resolving disputes at times when the technical representatives of PRPs, regulatory agencies and affected parties arrive at irreconcilable differences of opinion. For this reason it is proposed that when decisions on work scopes can not be reached by consensus, they are ultimately resolved by the risk manager as part of these workshops or at least prior to initiation of the work.

4.2.3.2.4.2 Process for Agreeing How Studies Will Be Interpreted and Used Along With the Results of Previous Studies to Develop Remediation Goals for the Bay Sediments.

It is impossible to separate the design of studies in the work scope from consideration of how the results will be used to support development of sediment remediation goals. Because of the importance of this subject to the Problem Formulation process it is addressed in this separate section to illustrate several points. In Xcel Energy's opinion a good illustration of how failing to agree on how the results of risk assessment studies should be used to develop sediment remediation goals is the amount of debate that has taken place over the last five years on how the results of sediment bioassays should be interpreted and used to support a sediment remediation goal. In the most recent WDNR memorandum (December 30, 2003), more than 20 pages are devoted to discussing the issue of how the various bioassay studies should be used to derive a preliminary remediation goal. This follows other memoranda over the last several years prepared both by WDNR and URS debating this same subject. This record of disagreements highlights the advantage a systematic problem formulation process provides – that initial agreement among stakeholders for a proposed study will avoid or, at least, minimize contentious conflict after data analyses.

Xcel Energy believes that if each proposed study is discussed among all potentially affected parties or their technical representatives with the objective of reaching consensus on the use of the results, there is likely to be agreement before the initiation of studies. The risk of significant differences of opinion after the studies are conducted will therefore be minimized and should not result in controversy and delays.

Xcel Energy also recommends that this approach should be used to decide the relative importance of each of the studies in the process of setting remediation goals for Bay sediments.

While agreement on a formal and quantitative weight of evidence scheme may not be achievable as suggested in WDNR's December 30, 2003 memorandum, Xcel Energy believes that the Bay sediment site is not so complex that potentially affected parties cannot initially agree on the relative importance of each study to determine the sediment remediation goal.

4.2.3.3 Conduct of Problem Formulation

The baseline problem formulation process is envisioned as two separate, facilitated, workshops over a four month period. These workshops will be preceded by distribution of the proposed risk assessment investigation work scopes to prospective affected parties. This will include Xcel Energy's proposals for:

1) A management goal, management objectives and general assessment endpoints for the risk assessments for ecological risk assessment;
2) A summary of exposure pathways to be evaluated in the human health risk assessment process;
3) Preliminary work scopes for risk assessment and sediment stability studies;
4) A process for discussing and refining work scopes; and,
5) A process for deciding how the results of the studies will be interpreted and used to develop Remediation Goals for the Bay sediments.

The overall objective of the workshops will be to solicit input that would assist with the further planning of the remedial investigation/feasibility study (including identification of areas and chemicals of concern, refinement of assessment endpoints, and selection of measurement endpoints), and to assist in the refinement of the work plan.

It is proposed that two workshops will be held. The proposed agenda for the first workshop is found in Appendix E. The first workshop will take place over two days and will be focused on providing a common ground for later discussions, reaching agreement on those issues that are not too controversial and identifying those issues where agreement will be more difficult to reach.

The second workshop will follow as a two or three day effort with presentations by potentially affected parties and/or their technical representatives. To get different opinions on the conduct of some studies or their utility in supporting the selection of remedial goals for sediment, outside experts including some of USEPA's research scientists may be invited to make presentations. Members of CSTAG also may find it worthwhile to attend.

4.2.3.4.1 Participants

The following participants are suggested:

- USEPA
- WDNR
- City of Ashland
- Local Indian Tribes
- NOAA
- Community Representatives (e.g., League of Women Voters, Ashland Chamber of Commerce, etc.)
- Environmental Organizations (e.g., Lake Superior Alliance, Sierra Club, etc.).
- Xcel Energy
- Northland College

4.2.3.4.2 Facilitation

This workshop will be professionally facilitated by the Sigurd Olsen Environmental Institute under the auspices of the Community Relations responsibilities described in Task 2 of the Scope of Work attached to the Administrative Order on Consent between Xcel Energy and USEPA.

4.2.3.4.3 Schedule Implications

Because there already have been initial Problem Formulation activities and public participation efforts, Xcel Energy believes that the process described here can be completed in approximately four months. A schedule is provided in Appendix E.

4.2.3.4 Outcome

Xcel Energy believes that there will be at least three important outcomes to the problem formulation process:

1) It engenders participation by the parties who are affected by the eventual decision.
2) It can result in different studies or different study designs than otherwise would have been conducted.
3) During the Problem Formulation issues related to natural resources and remediation are inevitably discussed. As a result, potentially affected parties, particularly PRPs, are able to evaluate site studies and site management much more holistically than with the more linear CERCLA approach. In Xcel Energy's opinion this is complementary and not contradictory to the CERCLA approach and ultimately makes the process more time and cost efficient.

4.2.3.4.1 Potentially Affected Parties Will Take "Ownership" of the Studies and Their Use

A study cannot be designed until the objectives of the study are explicitly defined. For studies conducted to support risk assessment and risk management decisions, the process of defining these objectives is embodied in the problem formulation process, including the identification of the management objectives and goals, assessment endpoints and risk questions. Consensus on these objectives leads to a more solid foundation for the design and interpretation of studies that are conducted. Potentially affected parties involved in that process are more likely to support the process, and less likely to be critical of the results and use of the results to make risk management decisions.

Under the usual CERCLA public participation process, even if the details of the proposed studies are provided to potentially affected parties prior to the conduct of those studies, the process of review, comment and modification of the studies is limited. Aside from the responses to comments on the design of studies, there generally is no attempt at reaching consensus. Because the potentially affected parties have not had material input into the design of the studies, they do not feel compelled to support the studies when they are completed. Studies are conducted and debate ensues as to whether the design and methodology used in the study was appropriate to establish sediment remediation goals.

Conversely, if the process of developing the basis and design of the risk assessment studies is a participative one, then during that process the relationship between the results of the studies and their use in establishing sediment remediation goals should become more transparent.

4.2.3.4.2 May Lead to Changes in the Type, Scope and Design of Studies

One of the important outcomes of a participative problem formulation process is that it is an active process where ideas can be challenged and debated. It is possible to differentiate, at the beginning, between those investigations that are "research-like" in nature and have little relevance to remedial decision making, and those that would be useful for supporting a selection of a sediment cleanup target. In this manner, emphasis and resources can be directed toward only those studies that will be meaningful in supporting a decision on a sediment remediation goal. Following are examples of Xcel Energy's perspective on some studies that may be relevant to the Bay sediments:

1) Xcel Energy believes that the previous resources put into conducting bioassays using UV light were unnecessary:

    a. The effect of UV light on biota is an area of active research and there is debate over its importance in the actual environment;
    b. It is nearly impossible to replicate in the laboratory the complex conditions and resulting UV regime experienced by benthic receptors in the environment, so the results are not representative of the real world; and
    c. Xcel Energy would have agreed, without conducting sediment bioassays using UV, that a conservative uncertainty factor should be applied to the results of sediment bioassays conducted under natural light when using those results to establish remediation targets.

2) Xcel Energy believes it is unnecessary to conduct bioaccumulation monitoring with mussels under the existing conditions at the site:

    a. Regardless of where mussels are placed in the Bay area, it is highly likely uptake of contaminants by the mussels is the result of the most heavily impacted areas of the Bay, much of which will be remediated;

b. Regardless of the magnitude of uptake of contaminants by the mussels the results of this study are not useful in determining sediment cleanup levels whether considering direct exposure or exposure through the food chain; and

c. Xcel Energy will agree without conducting any mussel bioaccumulation that contaminants found in the water column, either dissolved or associated with suspended particulates, are likely to be taken up by mussels that would be placed in the vicinity of the more highly impacted sediment.

3) Xcel Energy believes that a benthic community study is a useful line of evidence for identifying appropriate sediment cleanup targets for the Bay sediment:

a. Xcel Energy believes, however, that the study design proposed by SEH is inadequate to support an understanding of “exposure response gradient” that was SEH’s stated objective in its RI Work Plan; and

b. Because Xcel Energy believes this line of evidence is one of the most important to identify effects levels and thus to support a sediment remediation goal. As a result, a much more comprehensive sampling design has been proposed.

4) Xcel Energy does not believe that further studies of fish tissue, while important for supporting a baseline risk assessment, have any utility for establishing a sediment remediation goal:

a. Any contaminants found in fish caught under current conditions probably originate in more heavily impacted areas, which include many areas that will likely be remediated. No study of tissue burdens of mobile species will be able to differentiate the source of these contaminants within a small area relative to their range. The results of the study will therefore not be useful in supporting a sediment remediation goal; and

b. The evaluation of contaminants in fish tissue in the baseline risk assessment will have no bearing on risk management decisions.

Consequently, the results from earlier fish tissue analysis can be used for the risk assessment.

These few examples illustrate the type of issues that might be discussed and debated during an interactive Problem Formulation process. It is expected that other parties participating in this process would not only have their own perspectives on the issues, but have unique issues that could be discussed by all.

4.2.3.4.3 May Facilitate a More Comprehensive Understanding of Site Studies and Site Management Options

During Problem Formulation, issues related to natural resources and remediation are inevitably discussed. As a result, participants in the Problem Formulation process, particularly PRPs, are able to evaluate site study objectives and site management alternatives much more holistically than with the more linear CERCLA approach, helping the remedial investigation process become more time and cost efficient. As an example, since environmental impact issues can be discussed in the presence of all participants it is possible that the scope of the RI studies may be modified at a nominal cost to address potential natural resource issues.

With regard to addressing potential remedial alternatives, feedback from potentially affected parties during the Problem Formulation process can bring more focus to the objectives of studies conducted at this time. Knowledge of the range of remedial alternatives that may be acceptable could allow the PRPs to modify or expand the scope of the RI studies and acquire the necessary information to support the feasibility study without having to re-mobilize and conduct further studies at a future time. This has obvious advantages in terms of cost effectiveness as well as decreasing the time needed to complete the RI/FS process and decide and implement a remedy.

4.2.3.5 Summary

In summary, Xcel Energy recommends that before implementing any further investigations to support an ecological risk assessment and future risk management decisions for the Bay sediments, additional baseline problem formulation efforts should be conducted with the <u>active</u> involvement from individuals in the community and other stakeholders. This work scope has described how Xcel Energy envisions the process to take place.

1) Xcel Energy will distribute to all potentially affected parties, information on their approach and rationale for the RI studies. This rationale will be supported by Xcel Energy's proposals for risk assessment and risk management objectives, i.e., management goals and objectives and assessment endpoints;
2) Two workshops will be conducted to solicit input from all potentially affected parties to refine study designs and objectives, if necessary;
3) One of the primary objectives of these workshops will be to reach a consensus on how the results of the new and previous studies should be used to support sediment remediation goals;
4) Additional input will be solicited from participants in the Problem Formulation process on natural resource issues and remedial action constraints, permitting the design and objectives of the studies to be modified to address some of these related objectives, if it proves to be cost and time effective to the PRPs; and
5) Lastly, Xcel Energy believes this process can be completed by the end of June 2004, allowing the Studies to be conducted this summer and fall.

Xcel Energy believes that if the remaining components of the Problem Formulation process are conducted as proposed in this work plan, there is high probability that the remediation of the Bay sediments will be accomplished in less time and at less cost than if the RI process is implemented in the more traditional manner as has been conducted to date.

5.0 RI/FS TASKS

5.1 PROJECT SCOPING AND SUPPLEMENTARY PROJECT PLANS

Section VI of the SOW appending the AOC includes the following RI/FS tasks:

Task 1:	Project Scoping and RI/FS Planning Documents
Task 2:	Community Relations Support
Task 3:	Site Characterization (the Remedial Investigation)
Task 4:	Remedial Investigation Report (including Baseline Human Health and Ecological Risk Assessments)
Task 5:	Development and Screening of Alternatives (Technical Memorandums)
Task 6:	Treatability Studies
Task 7:	Detained Analysis of Alternatives (FS Report); and
Task 8:	Progress Reports

Project scoping (Task 1) activities are described in Section 5.1.1 and, planning document preparation (Tasks 2) is described in Section 5.1.2. Tasks 3 through 8 are described in the following sections.

5.1.1 Project Scoping

Project scoping (Task 1) began with the review of Work Plans prepared by SEH and URS, and the preparation of a Technical Letter Report. In August 2003, Xcel Energy submitted its first draft Work Plan for the completion of a RI/FS based on data needs identified by WDNR, USEPA, and CSTAG. SEH prepared a Work Plan in October, 2003 for the completion of a RI/FS based on data needs identified by WDNR, USEPA, and CSTAG.

A Technical Letter Report dated December 15, 2003 containing a concise description of the similarities and differences between the SEH and URS Work Plans was presented to the USEPA. Information presented in that document formed the basis of the January 8, 2004 Technical Scoping Meeting among USEPA, WDNR, and Xcel Energy. USEPA prepared a Scoping Meeting Summary, which Xcel Energy received on January 19, 2004. The scoping meeting summary described issues discussed in the Technical Scoping Meeting, and served as a trigger for the submittal of this RI/FS Work Plan Rev 01 and associated Planning Documents.

5.1.2 Preparation of Supplementary Project Plans

In accordance with the AOC, the following plans have been prepared concurrent with this Rev 01 RI/FS Work Plan:

- A **Field Sampling Plan** (FSP) has been prepared that defines the sampling and data collection methods that will be used for the project. It includes sampling objectives, sample locations and frequency, sampling equipment and procedures, sample handling and analysis, and a breakdown of the samples to be analyzed consistent with the Quality Assurance Project Plan (QAPP).

- A **Quality Assurance Project Plan** (QAPP) has been prepared in accordance with USEPA guidance (EPA QA/R-5) for all RI/FS activities. The QAPP includes a description of the project objectives and organization, functional activities, and quality assurance/quality control (QA/QC) protocols that shall be used to achieve the desired DQOs. These DQOs will specify the analytical methods for identifying contamination consistent with the levels for remedial action objectives identified in the National Contingency Plan.

- A site-specific **Health and Safety Plan** (HASP) has been prepared to specify employee training, protective equipment, medical surveillance requirements, standard operating procedures, and a contingency plan in accordance with 40 CFR 300.150 of the NCP and 29 CFR 1910.120(1) and(1)(2) for all RI/FS activities, including site visits.

- A **Project Management Plan** (PMP) has been prepared that outlines the procedures for storing, handling, accessing, and securing data collected during the RI. The PMP includes a **Data Management Plan** (DMP) that describes how a database will be utilized to manage the RI data.

5.2 COMMUNITY RELATIONS

In accordance with the AOC, the USEPA and WDNR have lead responsibility to implement community relations activities for the RI/FS. These activities include performing community interviews and developing a Community Relations Plan. The AOC further states that Xcel Energy may assist by providing Site history information, participating at public meetings, distributing fact sheets, and other tasks, but only as requested by USEPA.

Xcel Energy has a long history of public participation on the NSP/Ashland Lakefront Site. Public meetings have been held dealing with different technical issues, in coordination with the WDNR, the Ashland League of Women Voters, and the Sigurd Olsen Environmental Institute (SOEI) at Northland College. These meetings have been attended by many of the same stakeholders that will have an active participation in the future community relations activities. Xcel Energy also understands that SOEI is the selected contractor to implement community relations activities for USEPA.

Xcel Energy has always stressed the importance of developing complete and accurate data with regard to existing conditions. The RI tasks proposed within this work plan should complete the data needs required for site characterization. However, the past history of public participation on the project has shown that the stakeholders believe they have an understanding of the site, whether accurate or not. That understanding has created the perception on their part of a range of remedial actions that should be implemented. Despite the interest that Xcel Energy has as the primary responsible party (RP), the company wishes to consider all stakeholders interests in the site. This is the intent of the CSTAG recommendations, as well as the directives of the latest USEPA guidance that advocates a problem formulation process to involve all stakeholders early and often in the planning stages of the project. This will avoid disputes after the RI is complete, and engender satisfaction for all the stakeholders at the time the ROD is issued.

Because of the project history, Xcel Energy strongly urges that USEPA consider the Problem Formulation Strategy (Alternative 2) for the Bay sediments as described in Section 4.2.3 of this work plan.[21] Xcel Energy has proposed stakeholder workshops in that Section that will be

[21] Xcel Energy does not wish to dismiss the upland areas and Kreher Park from the problem formulation process. However, the public relations history on the project has shown little controversy with the investigation approaches implemented by both WDNR and Xcel Energy at these areas. Consensus has been reached in the past with regard to

facilitated by SOEI. However, at the request of USEPA, a proposed Sampling Design Strategy (Alternative 1) is also included for the sediments that does not include stakeholder planning in a problem formulation process. Regardless of the approved alternative, the schedules for implementation of the problem formulation process for the sediments will not extend the schedule for the RI deliverables (See Section 6, and Appendix E).

Xcel Energy further suggests that USEPA utilize Decision Consequence Analyses (DCA) procedures in its community relations activities at the site. Xcel Energy has access to numerical models that are used in the implementation of these procedures. The software facilitates the process by categorizing the various stakeholder inputs, which in turn then applies probabilities to the outputs. It can be used for both project planning for sampling designs (such as the proposed problem formulation process for Alternative 2), as well as remedial alternative analysis in preparation for the feasibility study. The models utilize standard unit cost information as part of the inputs, which ultimately assign values to the various probabilistic outputs. These models are routinely utilized in corporate strategic plans in the industrial market, but are not common in environmental applications. However, they have been used with success in other USEPA regions for large RI/FS applications, and have recently been included in the SOW of an AOC in Region 6.

Regardless of the alternative USEPA chooses for the investigation of the sediments, Xcel Energy offers to make its DCA tools available to the Agency and SOEI in its community relations efforts. The company recommends that a meeting be held between Xcel Energy, the agencies and SOEI to demonstrate the power of these tools, and to provide sufficient time for a decision to be made to permit their application.

5.3 DATA ACQUISITION AND FIELD INVESTIGATIONS

Additional data will be gathered from field investigations to further characterize site conditions. Field investigations will be completed in each area of concern to define physical and biological

investigating these areas, as it has in the development of the investigation approach for these areas described in this work plan. While one of the technical issues that must be resolved is the sediment/groundwater interaction with the Kreher Park fill, the sediments have been the focus of much of the past stakeholder concerns. Consequently, the problem formulation process proposed in Section 4.2.3 is intended to satisfy the sediment concerns on the part of the stakeholders, while addressing the technical interrelationships of the entire site as part of this process.

characteristics of the Site. Characterization will include the collection of samples from impacted media (i.e. surface soil, subsurface soil, soil gas, sediment, and groundwater) to identify the lateral and vertical extent of contamination. Data regarding the mobility, persistence, and characteristics of source areas will also be gathered to evaluate potential remedial responses. Additional data gathered and historical data will be used to characterize the nature and extent of contamination, and to evaluate the fate and transport of contaminants.

All field investigations will be completed in accordance with the Site-specific HASP. Diggers Hotline will be contacted for utility clearance prior to completing the Geoprobe soil borings, or well installation soil borings. Xcel Energy will also obtain permission from adjacent property owners for the purpose of collecting surface and subsurface soil samples, and well installation as needed. The site work will be scheduled with a contractor, and the agencies will be notified of the field schedule a minimum of 14 business days prior to site mobilization for the field investigation.

Prior to initiating any of the sampling efforts, a complete site survey will be performed. This survey will produce a detailed site topographic map referenced to the Wisconsin State Plane Coordinate System. The survey will specify existing and future sample coordinates for location of the GIS database.

5.3.1 Upper Bluff / Filled Ravine Area Sampling Program

A field investigation will be completed at the Site to further characterize contamination in the ravine fill in the Upper Bluff area. The investigation will include the following tasks:

- The collection of surface soil samples in the vicinity of the former MGP;
- The collection of additional soil samples from Geoprobe soil borings advanced in the backfilled ravine in the vicinity of the former MGP;
- A hydrogeologic investigation of the upper most water bearing units in the Upper Bluff area, which will include the measurement of fluid levels and collection of groundwater samples from existing wells; and,
- A vapor intrusion investigation to evaluate the potential air inhalation pathway.

The collection of surface and subsurface soil samples in the Upper Bluff Area in the vicinity of the former MGP is described in Section 5.3.1.1. The hydrogeologic investigation of the Upper Bluff Area is described in Section 5.3.1.2, and the vapor intrusion investigation of Upper Bluff Area is described in Section 5.3.1.3.

5.3.1.1 Upper Bluff / Filled Ravine Area Surface Soil and Subsurface Soil Sample Collection

Surface soil samples will be collected to evaluate potential contamination within surficial soils for the direct contact risk to human health. Samples SS-1 through SS-8 will be collected from unpaved areas in the vicinity of the former MGP facility and filled ravine area. Samples collected from the SS-9, SS-10, SS-11, and SS-12 locations will be used to represent background conditions. Soil sample locations SS-1 through SS-12 are shown on Figure 11.

At each sample location, soil will be collected from a depth between 3 and 12-inches utilizing hand tools. Samples will be placed in laboratory containers, held on ice, and shipped to the laboratory along with a completed chain-of-custody form. All samples will be analyzed for VOCs, SVOCs, and inorganic compounds included in Table 1 of this work plan.[22] Surface soil samples will be collected in accordance with Standard Operating Procedures (SOPs) included in the FSP.

Additional soil samples will be collected from borings advanced in the vicinity of the former MGP and adjacent filled ravine area to further characterize subsurface contamination in this area. Approximately 38 Geoprobe borings will be advanced in a regular grid pattern south of St. Claire Street in the courtyard area, inside the portion of the Xcel Energy building between the courtyard and alley, and in the alley. Four borings will also be advanced inside the former MGP building south of well nest MW-8/8A. Soil sample locations are shown on Figure 11.

Geoprobe borings will be advanced a minimum of five feet below the base of the filled ravine, or to a maximum depth of 20 feet. Soil samples will be collected continuously, and visually classified in accordance with the Unified Soil Classification System by a geologist or qualified soil scientist. Samples will be collected every two feet, and field screened with a photo-

[22] Table 1 is a list of compounds that was determined by Battelle under contract with SEH as site specific contaminants. This list was derived by Battelle following data review and validation on historic site analytical results.

ionization detector (PID) equipped with a 10.6 eV lamp. A minimum of three samples per boring will be collected for laboratory analysis. One sample will be collected from the unsaturated zone. Field screening results will be used to collect a sample which indicates the highest concentration of contamination, or the base of the backfilled ravine if contamination is not encountered. The third sample will be collected from the deepest interval, or from the deepest interval where field screening indicates that contamination is not present. All soil samples will be analyzed for VOCs, SVOCs, and inorganic compounds included in Table 1 of this work plan. Geoprobe soil samples will be collected in accordance with SOPs included in the FSP.

Additional subsurface soil samples will also be collected from three Geoprobe borings to evaluate background conditions. Background subsurface soil samples will be collected at intervals of 5, 10, and 15 feet from three borings advanced on the Xcel Energy property south of the former MGP. These three borings will be advanced within 15 feet of the North side of Lakeshore Drive between Prentice and 3rd Avenues at locations 50, 100, and 150 feet west of Prentice Avenue. These locations were chosen to represent up gradient soil background conditions outside the limits of the filled ravine. Three samples per boring will be selected for laboratory analysis. Background subsurface soil samples will be analyzed for VOCs, SVOCs, and inorganic compounds included in Table 1 of this work plan. Geoprobe soil samples will be collected in accordance with SOPs included in the FSP.

5.3.1.2 Upper Bluff / Filled Ravine Area Hydrogeologic Investigation

Groundwater samples will be collected from existing water table observation wells installed in the upper most water bearing unit in the Upper Bluff / Filled Ravine Area. The upper most water bearing units in this area include the Miller Creek Formation, and perched water in the backfilled ravine. (As described in Section 2.2, the Miller Creek is a fine grained low permeability unit deposited as a glacial till. This unit behaves as the confining unit for the underlying Copper Falls Aquifer. In the vicinity of the former MGP facility, the Miller Creek Formation is dissected by a ravine that formerly drained to Kreher Park and Chequamegon Bay to the north.) Existing wells installed in the Miller Creek Formation and the backfilled ravine hydrogeologic units are summarized below.

Upper Bluff Area		
Miller Creek Formation Wells	**Filled Ravine Wells**	
MW-8 MW-10 MW-11 MW-16 MW-17	MW-1 MW-2 MW-3 MW-4 MW-5 MW-6	MW-7 MW-9 TW-13 MW-14 MW-15

Prior to sample collection, fluid levels will be measured in all wells. The depth to water, depth to bottom, and the general condition of the well will be recorded on field sampling forms and summarized in the field log books. If encountered, the thickness of free-phase hydrocarbons will also be recorded. Each well will then be purged by removing four well casing volumes, or bailing the well dry. The color, odor, turbidity of the purge water and any problems encountered at the time of sample collection will be recorded. Groundwater samples will be placed in laboratory containers, held on ice, and shipped to the laboratory along with a completed chain-of-custody form. Groundwater samples will be collected in accordance with SOPs included in the FSP.

All samples will be analyzed for VOCs, SVOCs, and inorganic compounds included in Table 1 of this work plan. (These samples will be collected concurrent with the collection of groundwater samples from the Copper Falls Aquifer and Kreher Park as described in Section 5.3.2.1 and 5.3.3.2, respectively.) Groundwater samples will be collected quarterly during the months of March, June, September, and December. Six rounds of groundwater samples will be collected beginning with the quarterly monitoring month following piezometer installation.

5.3.1.3 Upper Bluff / Filled Ravine Soil Vapor Intrusion Investigation

Air samples will also be collected to evaluate the inhalation pathway for exposure to potential hazardous vapors generated at the site. The soil vapor intrusion investigation will consist of the collection of indoor air samples and air samples from vapor monitoring probes. All vapor samples will be collected in accordance with SOPs included in the FSP and USEPA draft guidance (December 2001) entitled *Evaluating The Vapor Intrusion To Indoor Air Pathway From Groundwater and Soils.* Air samples will be collected at the following locations:

- Inside the Xcel Energy service center building from the lowest elevation adjacent to an exterior wall near well MW-15;
- From vapor monitoring probe VP-1 installed in the filled ravine area east of the Xcel Energy administration building near the southeast corner of the asphalt parking lot;
- From vapor monitoring probes VP-2S and VP-2D installed in the filled ravine south of and along St. Clair Street, north of the paved courtyard area;
- From vapor monitoring probes VP-3S, VP-3I, and VP-3D installed near well MW-2R in the Xcel Energy storage yard north of St. Claire Street; and
- From vapor probe VP-4 installed east of MW-2R and approximately 25-feet east of the edge of the filled ravine.

Vapor monitoring probes will be installed in shallow soil borings advanced with a Geoprobe drill rig. Each probe will consist of a Geoprobe implant and small diameter tubing encased in a flush mount well casing cemented in place. Geoprobe implants are small diameter (1/4 – 3/8-inch) wire screens constructed of double woven stainless steel. Implants will be installed by advancing the drill rod to the target depth, inserting the implant through the drill rod. The implant is then connected to a drive point on the lead drill rod. When the drill rod is pulled back, the implant is anchored in place by the drive point. Implants 6-inches in length will be installed with 12-inches of fine sand placed around the implant. Granular bentonite will be used to backfill the borehole annular space seal above the sand pack. Vapor probes will be installed in accordance with SOPs included in the FSP.

Implants will be installed in the unsaturated zone at shallow, intermediate, and deep intervals. Implants installed at the deep interval will be installed approximately one foot above the saturated zone to evaluate the migration of soil vapors from groundwater. Shallow interval implants will be installed in native soil approximately 2-feet below ground surface to evaluate the migration of vapors to the surface. An implant will be installed at an intermediate interval at locations where the unsaturated zone is thicker than 10 feet. At the VP-1 and VP-4 locations, implants will be installed at shallow intervals between 1 and 2 feet below ground surface to evaluate the migration of vapors from known areas of contamination. (VP-1 is located in the filled ravine, but up gradient from the MGP facility. VP-4 is located 25 feet away from the filled ravine.) Because subsurface coal tar contamination is present at the VP-2 and VP-3 locations, implants will also be placed at multiple intervals at these locations. At the VP-2 location, the unsaturated zone is approximately 5-feet thick. (Groundwater has historically been encountered at an approximate depth of 5 feet in well TW-13). The implant for VP-2S will be installed between 1 and 2 feet bgs, and the implant for VP-2D will be installed between 3 and 4 feet bgs. At the VP-3 location, the unsaturated zone is approximately 15-feet thick. (Groundwater has historically been encountered at an approximate depth of 15 feet in well MW-2R). The implant for VP-2S will be installed between 1 and 2 feet bgs, and the implant for VP-2D will be installed between 13 and 14 feet bgs. The implant for VP-3I will be installed between 1 and 2 feet bgs, and the implant for VP-2D will be installed between 6 and 7 feet bgs.

Two rounds of air samples will be collected. The first round of samples will be collected a minimum of one week following vapor probe installation. Assuming the first round is collected during the spring, summer, or fall, the second sample will be collected during the winter months (frozen conditions). Air samples collected from vapor probes will be collected concurrent with the indoor air sample. Prior to collecting the indoor air sample, background conditions will be evaluated. This evaluation will include the following steps:

Step 1 Inspect the sample location area to identify consumer products (e.g. cleaners, paints, or glues) that may contribute to increased indoor air concentrations absent any subsurface contribution.

Step 2 Complete an occupant survey to identify occupant activities (e.g. smoking, welding, or operations of small engines, gasoline power tolls, or fleet vehicles) that may contribute to increased indoor air concentrations absent any subsurface contribution.

Step 3 Remove or prevent use of all potential sources that may contribute to increased indoor air concentrations absent any subsurface contribution for a minimum of 24 hours before sample collection.

Step 4 Collect an ambient (outdoor) air sample in conjunction with the indoor air sample.

All air and background samples will be analyzed for VOCs by Method TO15. The VOCs included in this analysis are listed in Table 2 of this work plan.[23] All samples will be collected in summa canisters provided by the laboratory, and shipped via overnight courier to the laboratory. Summa canisters are shipped from the laboratory under negative pressure; when the valve on the canister is opened air is drawn into the canister. A regulator will be used to collect the indoor air sample over a 24 hour period; the background sample will be collected over a one-hour period. Grab samples will be collected from the vapor probes by connecting the canister to the tubing, and opening the valve. These canisters will be filled in less than one minute. Air samples will be collected in accordance with SOPs included in the FSP.

The air sampling results from probes will be applied to the Johnson and Ettinger model (see Section 4.2.1.1) and compared to the indoor air sample results. Depending on data obtained from VP-1, an indoor air sample may be collected from the administration building. The model output will serve as the basis to evaluate any indoor air detections.

5.3.2 Copper Falls Aquifer Sampling Program

A field investigation will be completed at the Site to further characterize hydrogeologic conditions and contaminant distribution in the Copper Falls Aquifer. The investigation will include the following tasks:

- A hydrogeologic investigation of the Copper Falls Aquifer, which will include the installation of additional piezometers, the measurement of fluid levels and collection of groundwater samples and free-phase hydrocarbons from existing wells and proposed wells;
- A borehole geophysical survey of peizometers installed in the Copper Falls, and
- The use of a visual camera to inspect two artesian wells in Kreher Park, if possible, the completion of borehole geophysical surveys on these wells.

The installation of additional piezometers in the Copper Falls Aquifer and the collection of groundwater samples are described in Section 5.3.2.1, and the borehole geophysical survey and visual camera inspection is described in Section 5.3.2.2.

[23] The TO-15 parameter list is larger than the VOCs list included in Table 1 soil/groundwater/sediments list derived by Battelle (see Footnote #19).

5.3.2.1 Copper Falls Aquifer Hydrogeologic Investigation

Additional piezometers will be installed in the Copper Falls Aquifer to further characterize the lateral and vertical extent of groundwater contamination at the Site. Proposed piezometer locations are shown on Figure 12. These wells will be installed as follows:

- MW-7B will be installed adjacent to MW-7A in the former seep area at a depth of 55 feet below ground surface (20 feet deeper than MW-7A);

- MW-23A will be installed in Kreher Park north of MW-21A and west of MW-7A. Piezometer MW-23A will be installed at the Miller Creek / Copper Falls interface at an approximate depth of 35 feet below ground surface, or a minimum of five feet below the . interface, whichever depth is shallower.

- Piezometer MW-23B will be installed in Kreher Park adjacent to MW-23A at a depth 20 feet deeper than MW-23B (approximately 55 feet below ground surface).

- MW-24A will be installed in Kreher Park near the intersection of Ellis Avenue and Marina Drive between Marina Drive and the Chequamegon Bay inlet shoreline. Piezometer MW-24A will be installed at the Miller Creek / Copper Falls interface at an approximate depth of 35 feet below ground surface, or a minimum of five feet below the interface, whichever depth is shallower.

- MW-25A will be installed in Kreher Park near the center of Kreher Park between Marina Drive and the Chequamegon Bay inlet shoreline. Piezometer MW-25A will be installed at the Miller Creek / Copper Falls interface at an approximate depth of 35 feet below ground surface, or a minimum of five feet below the interface, whichever depth is shallower.

- MW-26A will be installed in Kreher Park on the north side of the former waste water treatment plant between the former plant and the Chequamegon Bay inlet shoreline. Piezometer MW-26A will be installed at the Miller Creek / Copper Falls interface at an approximate depth of 35 feet below ground surface, a minimum of or five feet below the interface, whichever depth is shallower.

All soil borings will be installed in borings advanced with 4-1/4-inch ID hollow stem augers. Soil samples will be collected at 2½-foot intervals from the ground surface with a split-barrel sampler, and visually classified by a geologist. Selected samples of aquifer material will be collected for physical testing (e.g. grain size analyses). Soil samples will be field screened with a PID equipped with a 10.6 eV lamp. Field screening results will be used to select screen depth intervals. If coal tar is observed in recovered soil samples, the shallow piezometer well screen will be placed at that interval. If coal tar is not encountered in recovered soil samples, then the shallow piezometers will be installed at the Miller Creek/Copper Falls interface at the MW-23A, MW-24A, MW-25A, and MW-26A locations. The deep piezometer (MW-23B) will be installed in the Copper Falls Aquifer approximately 20 feet below the shallow piezometer (MW-23A).

All piezometers will be constructed with a 2-inch diameter schedule 40 PVC well casing and screen, and encased in flush mount protective well casing. Well screens five feet in length with 0.010-inch slot size openings will be used. The sand pack will be placed around the well screens as the augers are removed, and the annular space seal will be backfilled with bentonite slurry tremied in place. Access for well installation at the Kreher Park locations will be contingent on obtaining access from the City of Ashland.

A minimum of 12 hours after well installation, each well will be developed by removing ten well volumes of water. The elevation of the top of each PVC well casing will be surveyed relative to site datum. Drill cuttings will be temporarily stored on site until arrangements for disposal can be made. Purge water will be collected and discharged to the on-site treatment building. Drilling, borehole logging, well construction, and well development will be completed in accordance with SOPs included in the FSP.

Following the piezometer installation described above, groundwater samples will be collected from all piezometers installed in the Copper Falls Aquifer. Existing wells installed in the Copper Falls Aquifer and proposed RI/FS wells are summarized below.

Copper Falls Aquifer Piezometers						
MW-2AR MW-2BR MW-2C MW-4A MW-4B MW-5A	MW-5B MW-5C MW-6A MW-7A MW-7B* MW-8A	MW-9A MW-9B MW-10A MW-10B MW-13A MW-13B	MW-13C MW-13D MW-15A MW-15B MW-17A MW-18A	MW-18B MW-19A MW-19B MW-20A MW-21A MW-21B	MW-22A MW-22B MW-23A* MW-23B* MW-24A* MW-25A*	MW-26A* MW-2A(NET) MW-2B(NET) AW-1 AW-2

* RI/FS Proposed Well

Prior to sample collection, fluid levels will be measured in all wells. The depth to water, depth to bottom, and the general condition of the well will be recorded on field sampling forms and summarized in the field log books. If encountered, the thickness of free-phase hydrocarbons will also be recorded. Each well will then be purged by removing four well casing volumes, or bailing the well dry. The color, odor, turbidity of the purge water and any problems encountered at the time of sample collection will be recorded. Groundwater samples will be placed in laboratory containers, held on ice, and shipped to the laboratory along with a completed chain-of-custody form. Groundwater samples will be collected in accordance with SOPs included in the FSP.

All samples will be analyzed for VOCs, SVOCs, and inorganic compounds included in Table 1 of this work plan. (These samples will be collected concurrent with the collection of groundwater samples from the Upper Bluff Area and Kreher Park as descried in Section 5.3.1.2 and 5.3.3.2, respectively.) Groundwater samples will be collected quarterly during the months of March, June, September, and December. Six rounds of groundwater samples will be collected beginning with the quarterly monitoring month following piezometer installation.

Representative free-phase hydrocarbon samples will be collected from wells yielded more than one-foot of free-phase hydrocarbons. This material will be subjected to physical analyses interfacial tension, viscosity, specific gravity, and/or bulk density. These testing results will be used to derive residual saturation values for the tar in the aquifer to evaluate its existing relationship with the aquifer material and its future recovery potential.

5.3.2.2 Copper Falls Aquifer Borehole Geophysics and Well Casing Inspection

Borehole geophysics will be performed to verify subsurface geologic conditions at the MW-2C locations. Borehole geophysical tools will include a natural gamma survey and an induction log (electro magnetic conductivity) survey on well MW-2C. The outer black iron pipe casing installed in the MW-2C boring will interfere with the geophysical survey. Adjacent well MW-2BR will be utilized to log geologic conditions to a depth of 70 feet, and MW-2C will be utilized to log conditions below 70 feet.

Additionally, borehole geophysics will be performed on well MW-2A(NET) in Kreher Park. Well casings for artesian wells AW-1 and AW-2 will also be visually inspected and recorded on video tape with the aid of a downhole video camera. Depending on the results of this camera survey, borehole geophysical surveys may also be completed on artesian wells AW-1 and AW-2. (If metal casing was used to construct wells AW-1 and AW-2, the borehole geophysical surveys will not be completed because the metal casing will interfere with the geophysical survey.) The borehole geophysical survey and visual inspection of the wells located in Kreher Park is contingent upon obtaining access from the City of Ashland.

5.3.3 Kreher Park Sampling Program

A field investigation will be completed at the Site to further characterize contamination in Kreher Park. The investigation will include the following tasks:

- A hydrogeologic investigation of the upper most water bearing unit at Kreher Park will be completed, which will include the installation of additional water table observation wells, the measurement of fluid levels and collection of groundwater samples from existing wells and proposed wells;
- The installation of piezometers along the Chequamegon Bay shoreline and a staff gauge to evaluate the hydraulic connection between groundwater and surface water;
- Exploration test pits at Kreher Park to characterize the former seep area, the former solid waste disposal area, and former drainage ditches/culverts; and,

- The collection of additional subsurface soil samples from Geoprobe soil borings advanced in the vicinity of the former seep and well TW-11 to evaluate the lateral extent of free-phase hydrocarbons in this area.

The hydrogeologic investigation in Kreher Park and evaluation of the hydraulic connection between groundwater and surface water is described in Section 5.3.3.1. Exploration test pits and subsurface soil sample collection is described in Section 5.3.3.2.

5.3.3.1 Kreher Park Hydrogeologic Investigation

Additional water table observation wells will be installed to further characterize the lateral extent of groundwater contamination in the upper most water bearing unit at Kreher Park. (As described in Section 2.2, the upper most water bearing unit at Kreher Park consists of fill material placed along the former shoreline). Additionally, piezometers with short well screens will be placed at the base of the fill adjacent to water table observation wells along the shoreline, and a staff gauge will be installed to evaluate the hydraulic connection between groundwater and surface water. Locations of proposed water table observation wells, piezometers, and the staff gauge are described below and shown on Figure 12.

- MW-7R will be installed adjacent to piezometers MW-7A/MW-7B at the former seep area at an approximate depth of 15 feet below ground surface;

- MW-24 will be installed at Kreher Park near the intersection of Ellis Avenue and Marina Drive between Marina Drive and the Chequamegon Bay inlet shoreline adjacent to piezometer MW-24A at an approximate depth of 15 feet below ground surface;

- MW-25 will be installed at Kreher Park near the center of the Park between Marina Drive and the Chequamegon Bay inlet shoreline adjacent to piezometer MW-25A at an approximate depth of 15 feet below ground surface; and

- MW-26 will be installed at Kreher Park on the north side of the former waste water treatment plant between the former plant and the Chequamegon Bay inlet shoreline adjacent to piezometer MW-26A at an approximate depth of 15 feet below ground surface.

All soil borings will be installed in borings advanced with 4-1/4-inch ID hollow stem augers. Soil samples will be collected at 2½-foot intervals from the ground surface with a split-barrel sampler, and visually classified by a geologist. Soil borings will be advanced to the base of the fill unit, or to a depth of 15 feet, whichever is greater. Each well will be constructed with a 2-inch diameter schedule 40 PVC well casing and screen, and encased in flush mount protective well casing. Well screens ten feet in length with 0.010-inch slot size openings will be used. Each well screen will be placed between 7 and 8 feet below the water table. The sand pack will be placed around the well screens as the augers are removed, and the annular space seal will be backfilled with granular bentonite. Access for well installation at these locations will be contingent on obtaining access from the City of Ashland.

Shallow piezometers P-24, P-25, and P-26 will also be installed adjacent to well nests MW-24/MW-24A, MW-25/MW-25A, and MW-26/MW-26A, respectively. These wells will be installed in a boring advanced with 4-1/4-inch ID hollow stem augers. Each shallow piezometer will be constructed with a 2-inch diameter schedule 40 PVC well casing and screen, and encased in protective well casing. Well screens one-foot in length with 0.010-inch slot size openings will be used. The sand pack will be placed around the well screen as the augers are removed, and the annular space seal will be backfilled with bentonite. Access for installation of these wells will also be contingent on obtaining access from the City of Ashland.

A minimum of 12 hours after well installation, each well will be developed by removing ten well volumes of water. The elevation of the top of each PVC well casing and ground surface at each well location will be surveyed relative to site datum. Drill cuttings will be temporarily stored on site until arrangements for disposal can be made. Purge water will be collected and discharged to the on-site treatment building. Drilling, borehole logging, well construction, and well development will be completed in accordance with SOPs included in the FSP.

Following the well installation described above, groundwater samples will be collected from all water table observation wells at Kreher Park. Shallow piezometers P-24, P-25, and P-26 will be utilized only for water levels. Existing wells and the proposed RI/FS wells are summarized below.

Kreher Park Wells			
MW-1 (NET) MW-2 (NET) MW-3 (NET)	MW-7R* MW-24* MW-25*	MW-26* TW-9 TW-11	TW-12

* RI/FS Proposed Well

Groundwater samples will be collected in laboratory containers, held on ice, and shipped to the laboratory along with a completed chain-of-custody form. These soil samples will be analyzed for VOCs, SVOCs, and inorganic compounds included in Table 1 of this work plan.

Prior to sample collection, fluid levels will be measured in all wells. The depth to water, depth to bottom, and the general condition of the well will be recorded on field sampling forms and summarized in the field log books. If encountered, the thickness of coal tar will also be recorded. Each well will then be purged by removing four well casing volumes, or bailing the well dry. The color, odor, turbidity of the purge water and any problems encountered at the time of sample collection will be recorded. Groundwater samples will be placed in laboratory containers, held on ice, and shipped to the laboratory along with a completed chain-of-custody form. Groundwater sample will be collected in accordance with SOPs included in the FSP.

All samples will be analyzed for VOCs, SVOCs, and inorganic compounds included in Table 1 of this work plan. (These samples will be collected concurrent with the collection of groundwater samples from the Upper Bluff Area and Copper Falls Aquifer as descried in Sections 5.3.1.1 and 5.3.2.2, respectively.) Groundwater samples will be collected quarterly during the months of March, June, September, and December. Six rounds of groundwater samples will be collected beginning with the quarterly monitoring month following well installation.

5.3.3.2 Kreher Park Exploration Test Pits and Subsurface Soil Sample Collection

Exploration test pits will be excavated at Kreher Park to further characterize the limits of fill for the solid waste disposal and the former coal tar dump areas. Two test pits will be excavated on each side of the former solid waste disposal area (eight total), and two test pits will be excavated across a former open sewer in this area. Test pits will also be excavated in the vicinity of the former coal tar dump to determine the lateral extent of contamination in this area. Two test pits will be excavated on the east and west sides, two in the center, one on the north side, and one on the south side of the former coal tar dump area (eight total). Additionally, three test pits will be excavated across former drainage ditches/culverts. As shown on Figure 3, a former open sewer drainage swale is located in the solid waste disposal area, and a former culvert/trench is located beneath the southwest corner of the waste water treatment plant north of the former coal tar dump, and a trench is located east of the former treatment plant. Proposed test pit locations are also shown on Figure 12.

Each test pit will be excavated to a depth between 6 and 8 feet. Material encountered in each test pit will be visually described, and photographed as needed. Test pits will be terminated when the limits of fill have been determined, or until obstructions or caving prevent additional excavation. Material removed from the test pits will be returned to the excavation. Grab samples of obvious solid waste material from the test pits will be collected, preserved and shipped for analysis for the Table 1 parameters. Based on these results, selected samples will be subjected to toxicity characteristic leaching procedure (TCLP) analyses for potential hazardous waste classification. [24]

Additional soil samples will be collected from Geoprobe borings advanced in the former seep area and in the vicinity of well TW-11 to identify the lateral extent of free-phase hydrocarbons in these areas. Approximately 12 Geoprobe borings will advanced in the vicinity of the former seep area, and approximately eight borings will be advanced in the vicinity of well TW-11; additional borings will be advanced as needed. Proposed boring locations are shown on Figure 12.

Borings will be advanced to the base of the fill, or to a maximum depth of 20 feet. Soil samples will be collected continuously, and visually classified in accordance with the Unified Soil Classification System by a geologist or qualified soil scientist. Samples will be collected every two feet, and field screened with a PID equipped with a 10.6 eV lamp. Field screening results will be used to select soil samples for laboratory analysis. Samples submitted for laboratory analysis will be selected at the rate of one sample for every 10 feet of drilling. These soil samples will be analyzed for VOCs, SVOCs, and inorganic compounds included in Table 1 of

[24] If obstructions or caving prevents the collection of soil samples from test pits, a Geoprobe drill rig will be mobilized to collect soil sample from borings advanced at the same location. Additionally, if free-phase hydrocarbons are observed in any test pit (e.g. sheen), test pits will be stepped out until no free product is encountered.

this work plan. Geoprobe soil samples from both areas will be collected in accordance with SOPs included in the FSP.

5.3.4 Chequamegon Bay Inlet Sampling Program

A detailed sampling design strategy has been presented in Section 4.2.2 of this work plan. A final Sediment Quality Triad sampling plan will be submitted for Agency review following the completion of a site reconnaissance to finalize sample locations (see Section 4.2.2).

5.4 SAMPLE ANALYSIS AND DATA VALIDATION

All soil, sediment, and groundwater samples collected during the RI will be analyzed by Northern Lakes Service, Inc. (NLS) of Crandon, Wisconsin. All air samples will be analyzed by Severn Trent Laboratories (STL) of Knoxville, Tennessee. Benthic community samples and sediment bioassays will be analyzed either by the URS benthic laboratory in Blue Bell, Pennsylvania or by a local laboratory to be determined.

Soil and sediment will be analyzed for constituents listed in Table 1. The first two rounds of groundwater samples will also be analyzed for constituents listed in Table 1. As described in Section 4.2.1.1, Xcel Energy recommends that groundwater monitoring results be evaluated after the first two rounds to reduce the number of samples collected each quarter, and to reduce or eliminate analyses for constituents that are not a concern. Air samples will be analyzed for constituents included in Table 2.

All samples will be collected and analyzed in accordance with the approved FSP and QAPP. As described in Section 5.1 above, both plans will be submitted for Agency review after the RI/FS Work Plan has been approved.

Upon receipt of data from each laboratory, all laboratory data collected during the RI will validated to ensure that the data are accurate and defensible. The data results will be reviewed against validation criteria. A Data Validation Report will be developed for submittal to USEPA after all data has been validated. Validated data will be submitted electronically in conformance with Region V standards as it becomes available with the monthly reports.

5.5 DATA EVALUATION

One of the first steps of the risk assessment process is to review data collected during site investigations in order to develop a data set to support the site-specific RA. The analytical data from the site will be reviewed in order to (1) validate and organize sampling data that were of acceptable quality for their use in the detailed RA; and (2) identify a set of constituents that are site-related. Presented below is detailed information with respect to the methods that will be used for the data quality evaluation.

5.5.1 Data Review Protocol

The QA/QC procedures for data collection and data analysis will be performed in accordance with the QAPP. Data generated under this program are anticipated to be technically sound, and of sufficient quality and quantity to support the needs of the data users.

Described below is information relative to the methods that will be used to develop a data set to support the development of the site-specific RA.

5.5.1.1 Tentatively Identified Compounds

Both the identity and reported concentrations of tentatively identified compounds (TICs) are highly uncertain. Therefore, TICs will be excluded from further evaluation in the RAs. Presented below is information with respect to the use of TIC data in the RAs.

QUALIFIER	DEFINITION	USE OF QUALIFIED DATA IN RA
N	The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification".	No.
NJ	The analysis indicates the presence of an analyte that has been "tentatively identified" and the associated numerical value represents its approximate concentration.	No.

5.5.1.2 Qualified Data

Qualifiers pertaining to uncertainty in the identity or the reported concentration of an analyte may be assigned to certain analytical data by the laboratories or by persons performing data validation. Presented below is information with respect to the use of qualified data in the RAs.

QUALIFIER	DEFINITION	USE OF QUALIFIED DATA IN RA
U	The analyte was analyzed for, but was not detected above the reported sample quantitation limit (SQL).	If the analyte is selected as a COC, then it will be assumed to be present at one-half the Practical Quantitation Limit (PQL).
J	The analyte was positively identified; however, the associated numerical value is an estimate of the concentration of the analyte in the sample.	If the analyte is selected as a COC, it will be assumed to be present at the estimated concentration.
UJ	The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is an estimate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.	If the analyte is selected as a COC, then it will be assumed to be present at one-half the PQL.
R	The sample results are rejected and are, therefore, unusable due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the analyte cannot be verified.	Data will be excluded from the quantitative RA.

5.5.1.3 Duplicate Results

Duplicate sample analytical results are averaged, and the average used as the sample point concentration. If both duplicate samples are non-detect, then the lower reporting limit is used as the sample point concentration. If one duplicate is reported as a detected value, while the other value is reported as a non-detect, then 1) if the reported detection is below the reporting limit for the non-detect, then only the reported detection is used as the sample point concentration; or 2) if the reported detection is greater than the reporting limit for the non-detect, then the average of the reported value and one-half the non-detect report limit is used as the sample point concentration.

5.5.2 Data Tabulation

To facilitate the data evaluation process, the analytical results will be tabulated and divided into groups by the area and environmental media of concern. Summary tables will be prepared in accordance with the format recommended in *Risk Assessment Guidance for Superfund (RAGS), Part A* (USEPA, 1989), to present relevant statistical data, such as the frequency of detection, the range of detected concentrations, the distribution of data set and the source term concentrations to be used in the RA.

5.6 RISK ASSESSMENT

5.6.1 Identification of Constituents of Concern

Described below are the procedures that will be used for selecting COCs to be further evaluated in the baseline human health risk assessment (HHRA).[25]

5.6.1.1 Constituents of Concern for the Human Health Risk Assessment

5.6.1.1.1 Comparison with Background Concentrations

Consistent with the USEPA Guidance, an inorganic constituent will be excluded from further consideration in the HHRA, if the maximum detected concentration is within the range of naturally occurring background levels.

5.6.1.1.2 Risk-based Screening Approach

Although the presence of many chemicals may be identified in the environmental samples collected during site investigative activities, the results of a baseline HHRA are typically driven by a few chemicals and exposure pathways. To streamline the HHRA process and focus efforts on important issues, several methods have been developed by the regulatory agencies and the scientific community for the identification of chemicals and pathways that contribute significantly to the total risks posed by a site. A tiered, risk-based approach will be used for the

[25] Section 5.6 addresses Human Health Risk Assessment concerns. References to the Ecological Risk Assessment (addressed in previous sections) deal only with human exposure pathways with respect to fish consumption.

selection of COCs to be further evaluated in the detailed risk assessment for the Site. This approach is based on USEPA-developed methodology and follows standard HHRA procedures. The maximum detected concentration of a chemical will be compared with chemical- and medium-specific risk-based screening concentrations (RBSCs), defined as concentrations that are not expected to result in any adverse impact based on exposure conditions which served as the basis for the calculation. A chemical will be selected as a COC if its maximum detected concentration value exceeds the RBSC.

For purposes of this project, the preliminary remediation goals (PRGs) derived by the USEPA Region 9 will be adopted as the primary source of RBSCs, because they have been derived based on conservative assumptions of exposure scenarios. In addition, the use of these PRGs for screening purposes is considered to be an acceptable practice by USEPA Region 5. It should also be noted that PRGs will be adjusted by a factor of 0.1 to account for possible additive effects of multiple constituents. RBSCs from other sources will also be used as described below.

For Constituents in Soil

- One-tenth of the PRGs calculated for soils under an industrial scenario will be adopted as RBSCs for selecting COCs in soil samples collected from areas used for industrial purposes.
- One-tenth of the PRGs calculated for soils under a residential scenario will be adopted as RBSCs for selecting COCs in soil samples collected from areas used for non-industrial purposes (e.g., recreational or residential use).

For Constituents in Groundwater

- The Maximum contaminant Level (MCL) will be selected as RBSCs for the purpose of identifying COCs in groundwater
- For chemicals lacking MCLs, one-tenth of the PRGs calculated for tap water under a residential scenario will be adopted as RBSCs for selecting COCs in groundwater samples.

For Constituents in Soil Gas

- A chemical detected in soil gas samples will be identified as a COC, if its maximum concentration exceeds the soil gas screening value provided in *Evaluating The Vapor Intrusion To Indoor Air Pathway From Groundwater and Soils (USEPA, 2001).*

For Constituents in Indoor Air Samples

- A chemical detected in indoor air samples will be identified as a COC, if its maximum concentration exceeds the screening value provided in *Evaluating The Vapor Intrusion To Indoor Air Pathway From Groundwater and Soils (USEPA, 2001).*

For Constituents in Ambient Air Samples

- One-tenth of the PRGs calculated for ambient air will be adopted as RBSCs for selecting COCs in the ambient air samples.

For Constituents in Surface Water

- Due to the lack of PRGs specifically derived for surface water, the Federal ambient water quality criteria (AWQC) established as protective of human receptors from risks associated with the use of surface water as the source of potable water will be adopted as conservative RBSCs for selecting COCs in surface water samples.

For Constituents in Sediment

- Due to the lack of PRGs specifically derived for sediments, one-tenth of the PRGs calculated for soils under a residential scenario will be adopted as RBSCs for selecting COCs in sediment samples.

For Constituents in Fish Tissue

- One-tenth of the PRGs calculated for fish tissue will be adopted as RBSCs for selecting COCs in tissue samples.

5.6.1.1.3 Frequency of Detection

A chemical that has been detected in fewer than 5% of the samples will not be selected as a COC, if sufficient number of samples have been collected for analyses. Based on *RAGS, Part A* (USEPA, 1989, see Section 2.0), at least 20 samples would be needed, if a frequency of detection limit of 5% is used as one criterion for eliminating compounds from further consideration in the baseline risk assessment.

5.6.1.1.4 Essential Elements

Under current HHRA guidance (USEPA, 1989), chemicals may be excluded from detailed risk analysis if they are considered to be essential nutrient requirements and are present at levels not likely to pose appreciable risk to human health. Chemicals that are generally considered to be essential nutrient requirements include calcium, chloride, iodine, magnesium, phosphorus, potassium, and sodium.

For the purpose of this HHRA, a chemical will not be selected as a COC, if it is considered an essential nutrient.

5.6.2 Baseline Human Health Risk Assessment

5.6.2.1 Guidance

This section describes the approach that will be used to develop a baseline HHRA for the Site. Guidance documents that will be used for the development of this HHRA include, but are not limited to, the following:

- Gilbert, R. O., 1987. Statistical Methods for Environmental Pollution Monitoring. Von Nostrand Reinhold, New York.

- *USEPA, 1989. Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual. Part A. Interim Final, December 1989. EPA/540/1-89/002. (*hereafter referred to as "RAGS, Part A".

- *USEPA, 1991. Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual, Part B, Development of Risk-based Preliminary Remediation Goals. Interim Final. EPA/540/R-92/003. (RAGS, Part B)*
- *USEPA, 1992a. Supplemental Guidance to RAGS; Calculating the Concentration Term. Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-081.*

- *USEPA, 1992b. Dermal Exposure Assessment: Principles and Applications. Interim Report. Office of Research and Development, Washington, D.C. EPA/600/8-91/001B.*

- *USEPA, 1992c. Guidance on Risk Characterization for Risk Managers and Risk Assessors. Memorandum from F. Henry Habicht II, Deputy Administrator, to Assistant Administrators. Regional Administrators. February 26, 1992.*

- *USEPA, 1994. Guidance on Residential Lead-based Paint, Lead Contaminated Dust, Lead Contaminated Soil. Washington, D.C. July 14, 1994.*

- USEPA, 1996. Soil Screening Guidance. Office of Solid Waste and Emergency Response.

- *USEPA, 1997a. Health Effects Assessment Summary Tables (HEAST), FY 1997 Update. July 1997. NTIS PB97-921199.*

- *USEPA, 1997b. Exposure Factors Handbook. National Center for Environmental Assessment. August 1997.*

- *USEPA, 2002. Region 9 Preliminary Remediation Goals (PRGs). USEPA, Region 9.*

5.6.2.2 Computation of Exposure Point Concentration

The Exposure Point Concentration (EPC) is defined as the 95% upper confidence limit (95% UCL) on the arithmetic mean concentration, or the maximum concentration, whichever is lower (US EPA 1992). Several statistics for the data must be calculated before the EPC can be determined. Section 5.6.2.2.1 describes how these summary statistics were calculated. Section

5.6.2.2.2 describes how this information was used to select EPCs for the risk evaluation. The methodology that will be used to derive concentration terms for constituents detected in site samples is described below.

5.6.2.2.1 Summary Statistics

Various summary statistics are calculated for each COC in each medium. Before summary statistics can be calculated, the following steps are taken for each COC:

- If a chemical is detected at least once in a medium, one half the SQL is used as a surrogate concentration for samples reported as "below detection limit" in the estimation of EPCs.

- For all non-detects for which one-half the SQL is calculated, the SQL is compared to the Reporting Limit (RL) or Method Detection Limit (MDL) for that chemical. Where the SQL is greater than five times the RL (for organics) or MDL (for inorganics), then one-half the RL or MDL is selected as a surrogate concentration for the non-detected result for the purpose of calculating the EPC.

- Duplicate sample analytical results are handled as described in Section 5.5.1.4.

5.6.2.2.2 Methodology

Risk Assessment Guidance for Superfund Sites (RAGS) (EPA 1989) outlines the process for assessing exposures using a reasonable maximum exposure (RME) approach in performing RAs. The RME is defined as the highest exposure that is reasonably expected to occur at a site using a combination of average and upper-bound values for contact and exposure (EPA 1989). Exposure or intake parameters are typically modeled using upper-bound values while the concentration term that a receptor is exposed to is "the arithmetic average of the concentration that is contacted over the exposure period" (EPA 1989; EPA 1992a). However, EPA (1989; 1992a) clarifies that "Because of the uncertainty associated with any estimate of the exposure concentration, the upper confidence limit (i.e., the 95% upper confidence limit) on the arithmetic average will be used for this variable." EPA (1992a) presents procedures to calculate the 95% UCL for datasets that are normally (using the student-t statistic) and log normally (using the H-statistic) distributed. However, neither EPA document (EPA 1989; EPA 1992a) provides guidance addressing datasets that are neither normal nor lognormal, or where the dataset contains a large number of non-detect values.

EPA (1997) evaluated alternative statistical procedures, specifically the Jackknife, Bootstrap, Central Limit Theorem and Chebychev Theorem, and compared them to the H-statistic method on lognormal distributions. Schultz and Griffin (1999) evaluated the H-statistic, Chebychev and Bootstrap methodologies (standard bootstrap, bootstrap- *t*, and Hall's bootstrap-*t* transformation). Both papers determined that the H-statistic was a poor predictor of an UCL (it tends to significantly over-predict the UCL as compared to other statistical methods) on datasets that are small (< 30 samples) or where there is a poor fit (w-test for log normality is < 0.05) (EPA 1997; Schultz and Griffin 1999).

As a result, the statistical procedure shown schematically in Figure 14 and discussed in the following sections was developed for characterizing the mean and 95% UCL. The approach is based on recommendations made in recent publications (e.g., EPA 1997, Schulz and Griffin 1999). It includes distribution testing to determine whether a dataset best fits a parametric (i.e. normal, lognormal) or nonparametric (non-normal) distribution, and then applies the appropriate statistical methods to calculate the mean and 95% UCL. The lower of the maximum detected value and the 95% UCL will be used to represent the EPC in risk evaluation. General application of the approach is discussed in the following section.

Data Usability and Adequacy of Samples

The adequacy of datasets to represent an exposure unit will be evaluated using criteria outlined in the EPA *Guidance for Data Usability in Risk Assessment* (EPA 1992b). Datasets containing at least one detected value but fewer than 5 samples are considered inadequate for distribution testing and the maximum detected value will be used to represent the dataset, unless additional samples will be collected. Datasets containing greater than 50% detects and five or more samples will be subjected to distribution testing.

Distribution Testing

Datasets of five or more samples will be evaluated for the presence of non-detects prior to performing distribution testing. Data sets will be separated into the following subgroups:

1) Data sets containing less than 50% non-detect values; and
2) Data sets containing from 50% to < 100% non-detects.

Distribution testing will be performed on each data set containing less than 50% non-detect values using all data. Surrogate values equal to one-half of the detection limit will be used for non-detect data. Where datasets contain 50% or more non-detect data, the dataset is considered inadequate to perform distribution testing and a non-normal or "mixed" distribution[26] will be assumed. In these instances, a non-parametric statistical approach will be used to develop the EPC.

Distribution testing will be performed using the following methodologies. First, the data and the natural log transforms of the data will be tested using the Shapiro-Wilks test (w-test) for normality. For data sets containing more than 50 samples, the D'agostino's test (the D-test) will be used. The D'agostino test is an extension of the w-test. The w-test is based on the null hypothesis that the data are normally distributed. The test will be performed with a type-I error rate of 5%. The type-I error rate (shown as the p-value in the w-test) is the probability of incorrectly rejecting the null hypothesis of normality. In the w-test, a test value < 0.05 results in rejection of the null hypothesis and it is assumed that the data are not normally distributed. For log normally distributed data, the log-transformed data will fit a normal distribution. The w-test for normality may be used to test data for lognormal distribution using the natural log transforms of the data.

The second method used will be the Anderson-Darling (A-D) test for goodness of fit. The goodness of fit test differs from the w-test in that the null hypothesis is that the data do not fit a selected distribution. Therefore, the burden of proof in the goodness of fit test is to show that the data provide a good fit to a selected distribution; whereas, for the w-test, the burden of proof is to

[26] The potential interference associated with high levels of non-detects is due to the potential for a bimodal distribution resulting from combining multiple and differing analytical method's reporting limit(s) and the distribution of the chemical concentrations – i.e., the data set represents a mixture of two (or more) statistical populations.

show that the data are not normal. For goodness of fit tests such as the A-D test, a p-value greater or equal to 0.9 is an indication of a good fit (Schulz and Griffin 1999).

The A-D test will provide a confirmation method of testing for a lognormal distribution. The results of the A-D test for lognormal fit will be used to corroborate the results of the w-test, particularly in cases where the log-transformed data appear not to be normal but the w-test p-value indicates that the null hypothesis of normality cannot be rejected. However, since the w-test is reputed to be one of the most stringent tests available for normality (Schulz and Griffin 1999), the w-test p-value will take precedence over the A-D test results to identify non-normal data.

95% UCL for Datasets that Fit a Normal Distribution

The population mean (μ) is a measure of the central tendency of a distribution. As such, it is an appropriate measure of the concentration in a medium (e.g. soil) that a receptor may contact throughout the duration of the assumed exposure. The population mean typically is estimated using the mean of sample data (i.e., the average) and an upper confidence limit of the mean. For datasets that fit a normal distribution, the 95% UCL will be calculated using the Student-t statistic with the following equation (from EPA 1992a):

$$UCL_{95} = \bar{x} + s \times t_{0.05,\, n-1} \Big/ \sqrt{n}$$

where :

	x	=	sample mean
	s	=	sample standard deviation
	$t_{0.05,\, n-1}$	=	one-sided t-statistic for 5% type I error
	n	=	number of samples

95% UCL for Datasets that Fit a Lognormal Distribution

Datasets will be considered lognormal where the w-test is greater than 0.05 for log transformed data sets and an Anderson-Darling test probability greater than 0.90. The 95% UCLs will be calculated using the H-statistic[27] as shown below (from EPA 1992a):

[27] The H-statistic is only functional for standard deviations between 0.10 and 10. If the dataset standard deviation is outside of the bounds, the Chebychev and bootstrap methods will be evaluated for use in lieu of the H-statistic methodology.

$$UCL_{95} = \exp^{\left(\bar{y} \times 0.5 S_y{}^2 + S_y \times H_{0.95,\,n,\,Sy} \big/ \sqrt{n-1}\right)}$$

where:
y = mean of ln transformed data
Sy = standard deviation of ln transformed data
$H_{0.95,n,Sy}$ = H-statistic for 95% confidence limit
n = number of samples

Besides the H-statistical method for datasets that fit a lognormal distribution, Schulz and Griffin (1999) recommend that an alternative method, specifically the Chebychev inequality method, be considered. The Chebychev method provides an alternative to and check on the H-statistic and is considered a conservative estimate of the 95% UCL of a distribution. EPA (1999) also provides additional information about the use of the Chebychev inequality to estimate the 95% UCL of log-normally distributed data. For log-normally distributed data, the mean and standard error of the mean may be estimated using Minimum Variance Unbiased Estimate (MVUE) equations presented in Gilbert (1987; pg. 165). The Chebychev inequality 95% UCL has been shown to be more conservative than UCLs calculated using the other methods described above (EPA 1999). Therefore, the Chebychev UCL provides a conservative estimate of the 95% UCL of lognormal data and will be used to evaluate whether the H-statistic generates a 95$^{\%}$ UCL that is unrealistically large. The Chebychev UCL equation is shown below:

$$UCL_{95} = \mu_1 + 4.47 \times \sigma(\mu_1)$$

where: μ_1 = ln MVUE mean estimate (Gilbert 1987)
$\sigma(\mu_1)$ = ln MVUE mean standard error (Gilbert 1987)

EPA (1997) has correlated the generation of unrealistic 95% UCLs based on the use of the H-statistic with data sets that exhibit high coefficients of variation (CV) and small sample sizes. A high CV is also problematic for the Chebychev inequality. The CV is defined as the ratio between the standard deviation of the data and the mean, expressed as a percentage. A high CV, according to EPA (1997), is greater than 100%. To correct for this EPA (1997) suggests the use of the Jackknife procedure in estimating the MVUE of the lognormal mean. To perform the Jackknife, the MVUE of the mean is calculated after deleting one observation at a time in sequence:

$$\phi_i = (n \bullet MVUE) - [(n-1) \bullet MVUE_{-i}]$$

Where $MVUE_i$ is the MVUE estimate after deleting the ith sample observation. The Jackknifed mean is then:

$$\Phi = \frac{\sum(\phi)}{n}$$

The Jackknifed standard error of the MVUE is the sum of squares for the Jackknifed estimates:

$$SE_{MVUE} = \sqrt{\frac{\sum(\phi_i - \Phi)^2}{n \bullet (n-1)}}$$

The UCL is then calculated based on the t-distribution and the Jackknifed standard error.

$$UCL_{95} = \Phi + t_{1-0.95,n-1} \bullet SE_{MVUE}$$

This method is recommended when unrealistic UCLs are suspected from the use of the H-statistic on log-normally distributed data, specifically when the CV is high (>100%) or when the sample size is low (<30 observations)(EPA 1997).

95% UCL for Datasets that are Neither Normal Nor Lognormal

Use of the equations shown above is inappropriate for datasets that, through distribution testing, fit neither a normal or lognormal distribution or are based on a “mixed” population of detects and non-detects. Therefore, alternative methods are used for estimating 95% UCLs for datasets that are considered non-normal. Non-normal datasets provide a poor fit to normal or lognormal distributions and particularly occur where data may be artificially skewed due to biased sampling or through the combination of samples from different populations that occur within a single exposure unit. The alternative statistical procedures that will be used for evaluating nonparametric distributions include:

1) Bootstrap;
2) Bootstrap-t;

3) Hall's Bootstrap-t Transformation; and
4) Jackknife

The major advantage of these methods is they can provide a robust approximation of the UCL without having to make assumptions regarding an underlying distribution to the data (EPA 1997). Any method can be used; however, the Jackknife method tends to be more robust and more conservative (and thus preferred) on datasets with fewer samples (e.g., sample sizes less than 15[28]). All of the bootstrap methods assume that the random re-sampling of the dataset will result in a dataset (i.e., of bootstrap means, t-statistic or Q-statistic) that will be normally distributed or nearly so. For high levels of bias, the bootstrap-t is designed to normalize the re-samples; while if the raw dataset is highly skewed, Hall's transformation is designed to normalize the re-samples.

The underlying premise of normality for the bootstrap methods can be compromised in highly "mixed" datasets (i.e., those with very high levels of non-detects) or by the presence of outliers within the dataset (see Frey and Burnmaster 1999, Kilian 1998, Kelly 1999). Outliers are particularly troublesome for the bootstrap methods causing violations of the assumptions required for the Edgeworth expansions used in the t-bootstrap and Hall's transformed t (see Hall 1992, Davidson and Hinkley 1997). The presence of outliers in the parent dataset can actually increase or exacerbate the skewness within the re-sampled datasets and even cause complete method failure (where the 95th percentile of the bootstrapped distribution is an empty set – see Hall 1992). Similarly, if the dataset contains a significant number of non-detects whose surrogate values are constant, the bootstrap re-sampled dataset can be of n samples with exactly the same value. If this occurs, there is no variance within the dataset and the bootstrap methods will fail. It has been observed that such failures occur most often in smaller datasets (e.g., < 15 samples) when the percent detection is less than 50%. A final salient issue regarding the bootstrap methods is a high level of variability between simulations based on small sample sizes, especially in wide ranging datasets. Under such circumstances, the jackknife method is far more stable (reproducible) and as such, the preferred method.

A basic discussion of these methods and the underlying assumptions of normality for the re-sampled data is provided in Efron and Gong (1983), Hall (1992), Davidson and Hinkley (1997)

[28] A sample size of 15 was selected as none of the validation exercises presented within the references have evaluated sample sizes less than 15 (see also Frey and Burmaster 1999).

as well as by EPA (1997), with further discussion of the bootstrap methods described in Schulz and Griffin (1999). A copy of Efron and Gong (1983), EPA (1997) and Schulz and Griffin (1999) are provided as attachments.

***Bootstrap Methods*:** The standard bootstrap, bootstrap-t, and Hall's bootstrap-t transformation reflect a technique that involves random re-sampling with replacement of a data set of size *n* to generate many additional simulated data sets of size *n* that may be examined for variability or uncertainty (Schulz and Griffin 1999). The standard bootstrap may provide confidence intervals that have less than nominal coverage probability due to bias and skewness reflected in the data (Schulz and Griffin 1999). Bias is defined as the relative difference between the raw data mean and the bootstrapped mean. Bias is not considered significant unless it exceeds 25% of the raw data variance (e.g., see Efron and Gong 1983). Sample skewness can be tested for significance using the methods presented in Gibbons (1994). If neither bias nor skewness is significant, the standard bootstrap is the preferred method because the bootstrap extensions such as the Studentized (bootstrap-t) and Hall's transformation (Edgeworth expansions) can result in variable results. The bootstrap-t method is preferred when bias is high and skewness is insignificant whereas when skewness is high, Hall's transformation is the preferred method.

The procedure for performing the bootstrap methods mentioned above for a data set containing *n* samples is described below:

Step 1: Calculate the raw data mean, standard deviation, and skewness:

$$\overline{X}_{raw} = \frac{\sum X_i}{n}$$

$$SD = \sqrt{\frac{\sum \left(X_i - \overline{X}_{raw}\right)^2}{n}}$$

$$v = \frac{\sum \left(X_i - \overline{X}_{raw}\right)^3}{n \times SD^3}$$

Where X_{raw} equals the mean of the raw data, SD_{raw} equals the standard deviation of the dataset, and v equals the skewness of the dataset.

Step 2: Randomly select n samples (with replacement) from the original n data and calculate the mean and standard deviation. Repeat 1000 times (minimum).

Step 3: Calculate the mean and standard deviation of each randomly drawn resample of the data set. Then calculated a W-value as follows:

$$W_i = \frac{\left(\overline{X}_{Bi} - \overline{X}_{raw}\right)}{SD_i}$$

Where X_{Bi} and SD_i are the mean and standard deviation of the ith resample of the data set and X_{raw} is the mean of the original data set. Repeat 1000 times.

Step 4: Calculate the Q statistic as a function of W for Hall's adjustment for skewness. Repeat 1000 times.

$$Q(W_i) = W_i + \frac{v \times W_i^2}{3} + \frac{v^2 \times W_i^3}{27} + \frac{v}{6 \times n}$$

Step 5: Rank the values W_i and $Q(W_i)$ from smallest to largest.

For the standard bootstrap calculate the bootstrap mean and standard error:

$$\overline{\overline{X}}_{GB} = \frac{\sum_{i=0}^{it} \overline{X}_{Bi}}{it}$$

Where *it* equals the number of iterations (re-samples; e.g., 1000), X_{Bi} equals the mean of the i^{th} resample and X_{GB} equals the bootstrap mean. The bootstrap standard error is:

$$\sigma_B = \sqrt{\frac{1}{it-1} \times \sum_{i=0}^{it} \left(\overline{X}_{Bi} - \overline{\overline{X}}_{GB}\right)^2}$$

The standard bootstrap 95% UCL is then calculated using the z-statistic:

$$95\%UCL = \overline{\overline{X}}_{GB} + Z_{0.05} \times \sigma_B$$

Considering the bootstrap-t method, the 50th ranked value[29] of W is used to represent "$t_{0.05}$" in the following equation for the 95% UCL:

$$95\%UCL = \overline{X}_{raw} - t_{0.05} \times SD_{raw}$$

Hall's bootstrap-t transformation proceeds by calculating the inverse of the Q(W) function of the ordered $Q(W_i)$ values:

$$W(Q_i) = \frac{3 \times \left\{ \left[1 + v \times \left(\frac{Q - v}{6 \times n} \right) \right]^{1/3} - 1 \right\}}{v}$$

Here again, if 1000 re-samples were taken, the 50th value represents the 5th percentile such that the 95% UCL is calculated as follows:

$$95\%UCL = \overline{X}_{raw} - W(Q)_{0.05} \times SD_{raw}$$

These bootstrap approaches have the advantage in that they do not rely on the assumption of a special parametric form for the distribution of the population (EPA 1997). The underlying assumption is however, that the calculated X_{Bi}'s t-statistics (W_i's), and Q(W)'s are normally distributed. Subsequent to the bootstrap calculations, the distribution of the bootstrap statistics (X_{Bi}'s, W_i's, and Q(W)'s) will be evaluated for departure from normality using the correlation between the expected quantiles of the normal distribution for the bootstrap output and the observed quantiles for the re-sampled datasets ($Q_{expected}$-$Q_{observed}$ plots; see USEPA 1998). Such Q-Q plots are considered one of the most effective means of evaluating the bootstrap normality "fit" (see Davidson and Hinkley 1997). If the assumption of normality or near-normality cannot be met, the jackknife procedure will be used.

[29] The 50th W value represents the 5th percentile given 1000 resamples.

Jackknife Method: The Jackknife procedure is similar to the standard bootstrap as described above. When the data cannot be defined as normal or lognormal and the sample size is below 15, the Jackknife is preferred as a more conservative method (e.g., see Efron and Gong [1983]). The jackknifed mean and standard error are calculated as follows:

Step 1: n pseudovalues (ϕ) are first calculated by leaving out each of the observations i in turn:

$$\phi = (n \times \overline{X}) - [(n-1) \times \overline{X}_{i-1}]$$

Step 2: The jackknifed estimate of the mean is then:

$$\Phi = \sum(\phi) \div n$$

Step 3: The standard error of the mean is calculated as:

$$SE_{mean} = \sqrt{\Sigma(\phi_i - \Phi)^2 / [n \bullet (n-1)]}$$

Step 4: The upper confidence limit of the jackknifed mean is calculated as:

$$UCL_\alpha = \Phi + t_{1-\alpha,n-1} \bullet SE_{mean}$$

5.6.2.3 Exposure Assessment

The exposure assessment is typically performed to estimate the type and magnitude of exposures to the COCs that are present at or migrating from sites included in the HHRA. The results of the exposure assessment will be integrated with chemical-specific toxicity information (described in Section 5.6.2.4) in order to characterize human health risks potentially associated with the sites (described in Section 5.6.2.5).

5.6.2.3.1 Site Characterization

The first step in the exposure assessment is to characterize sites included in the HHRA with respect to its physical characteristics as well as those of the human population on or near the

sites. Information gathered in this step will be used to support the identification and selection of exposure pathways that warrant further evaluation in the quantitative risk assessment.
Information pertinent to the characteristics of the physical setting of the sites, such as climate, geologic setting, hydrogeological setting, surface water features in site vicinity and soil type, is presented in Section 2.0 of this Work Plan.

The Site contains four affected areas of concern (ACs), shown on Figure 6. These include two ACs on the Xcel Energy property (the Upper Bluff/Filled Ravine and Copper Falls Aquifer), the Kreher Park area, and the affected offshore sediments. The filled ravine is a former drainage feature that begins near the Xcel Energy administration building fronting on Lakeshore Drive, and deepens and widens to the north (see Figure 7). The mouth of the ravine opens to Kreher Park through the bluff face at the north end of the gravel storage yard. The maximum depth of fill in the ravine at the mouth is approximately 33 feet. The Copper Falls Aquifer is a confined, variably coarse to fine-grained sand (reworked glacial till) that underlies the entire Lakefront site (see Figure 5). The formation is overlain by the surficial Miller Creek Formation, which is a lacustrine clay to silt till unit. At the Xcel Energy property, the Miller Creek has a maximum thickness of about 35 feet; the thinnest portion of the unit is at the mouth of the former ravine, at approximately four feet. The Miller Creek Formation is overlain by fill at the lakefront (Kreher Park) and at the buried ravine.

The offshore area with impacted sediments is located in an inlet created by the Prentice Avenue jetty and marina extensions previously described. For the most part, contaminated sediments are confined in the inlet bounded by the northern edge of the line between the Prentice Avenue jetty and the marina extension. Contaminated sediment levels quickly decline beyond this boundary. The affected sediments consist of lake bottom sand and silts, and are overlain by a layer of wood chips, likely originating from former lumbering operations. The chip layer varies in thickness from 0 to seven feet, with an average thickness of nine inches. The entire area of impacted sediments encompasses approximately nine acres.

The Ashland Lakefront property site can be divided into two basic areas for the purpose of HHRA. The upper bluff/ravine area and Copper falls aquifer consisting of AC 1 and AC 2 and the area defined by Kreher Park and the contaminated sediments AC 3 and AC 4. The upland areas are used for industrial or commercial purposes primarily but portions are subject to trespass. The areas which are public streets are readily accessible to the public although they are generally covered by clean fill or roadways. Except for the two artesian wells at Kreher Park, the Copper Falls aquifer is not used for drinking water and is not considered a source of human exposure.

The area near the lakefront is zoned CR, conservancy District; i.e., acceptable for use as parkland. The property is now comprised of City parkland (Kreher park). The area is readily accessible by the public and a majority of the site is mowed and maintained for public use. No physical barrier exists at the shoreline to prevent swimming or wading in the bay where the contaminated sediments have been found although warning signs are posted along the shore of affected area. Kreher park and the contaminated sediments are surrounded by facilities that draw the public to the lakefront—a City marina, public swimming beach, a boat ramp and an RV park and campground. Warning buoys also prohibit boats into the affected area.

There are two artesian wells in the site vicinity—one located near Prentice Avenue on the eastern boundary of the site and the other located near the marina on the western boundary. The artesian wells are available for the public to fill containers for drinking water. The water from the artesian wells originates from the deep confined aquifer located beneath the site. Drinking water at the site is provided by the City of Ashland that draws its water from intakes in Lake Superior, located approximately one mile northeast of the site.

According to the Ashland Wisconsin Waterfront Development Plan, the City has future plans for expanding the RV park, located immediately adjacent to the Ashland Lakefront property to the east.

5.6.2.3.2 Conceptual Site Model

Exposure pathways describe the movement of chemicals from sources (e.g., chemicals in soil or surface water) to exposure points, where receptors (i.e., potentially exposed populations) may come in contact with the chemicals.

An exposure pathway is typically defined by the following components (USEPA, 1989):

- A source and mechanism of chemical release to the environment;
- An environmental transport medium (e.g., air, water) for the released chemicals;

- A point of potential contact with the contaminated medium (i.e., point of exposure); and
- An exposure route (e.g., inhalation, ingestion, dermal contact) at the point of exposure

An exposure pathway is considered complete only if all four components are present. In conducting the baseline HHRA for the Ashland Lakefront Superfund Site, only complete exposure pathways will be evaluated quantitatively.
Described below is a conceptual site model for the Site developed to identify the focus of the HHRA. A schematic presentation of the conceptual site model is included as Figure 14.

Known and Suspected Sources of Contamination and Release Mechanisms

The source(s) of impacts at the site has not been definitely identified. Based on information with respect to the history of the facility and the results of previous investigations, the potential primary sources of contamination are associated with past industrial operations; e.g., former wood treatment activities on the site, or past releases from the former MGP, releases of petroleum based products from railcar off loading, releases from the former WWTP, and releases from filling activities at the Lakefront. Surface and subsurface soil and groundwater that have been impacted may act as secondary sources of contamination through mechanisms such as leaching of chemicals from soil, groundwater recharge to surface water and wind and mechanical erosion of chemicals in soil.

Retention or Transport Media

The medium directly impacted by past industrial activities is soil. Dust is considered a potential transport medium, because COCs in soil may become entrained in fugitive dust. Surface runoff is considered a transport medium, because storm events may have generated episodic overland flow and carried COCs away from disposal or spill areas.

Transport Pathway

Release mechanisms and transport pathways will be evaluated on a site-by-site basis. Listed below are potential cross-media transfer mechanisms of COCs:

- COCs in subsurface soil may enter groundwater;

- COCs in surface soil may be transported to surface water and sediments through surface runoff;
- COCs in groundwater may be transported to surface water and sediments through groundwater recharge;
- COCs in surface soil may be transported to the atmosphere via volatilization or fugitive dust emission;
- COCs in soil or groundwater may be transported to the atmosphere or indoor air through volatilization; and
- COCs in surface water and sediments may be transported to fish tissue through bioconcentration.

Receptors and Exposure Scenario

Presented below is an overview of populations of potential concern selected for further evaluation in this HHRA:

Exposure to COCs in Soil

Industrial/Commercial Land Use Scenario: Maintenance Workers

Kreher Park and the unpaved portions of the Upper Bluff area are subject to routine maintenance by City workers, Xcel Employees and utility maintenance personnel. For purposes of this HHRA, maintenance workers will be selected as the population of potential concern for COCs detected in surface soil samples collected from Kreher Park and the Upper Bluff area. It is conservatively assumed that maintenance workers may be exposed to COCs in surface soil (defined as soil within the top 1 foot from the ground surface) via incidental ingestion, inhalation (of soil borne vapor and particulates) and dermal contact pathways.

Industrial/Commercial Land Use Scenario: General Workers

Several areas are currently being used for industrial/commercial purposes. For this HHRA, general workers are defined as employees involved with non-intrusive, operational activities. Current and potential future general workers are not likely to be subject to significant exposure to environmental media in the normal course of their daily work. Although the potential for exposure to occur is expected to be low, general workers are assumed to be exposed to COCs in surface soil via incidental ingestion, inhalation (of soil borne vapor and particulates) and dermal contact pathways.

Industrial/Commercial Land Use Scenario: Construction Workers

AC 1,3, and 4 – Upper Bluff ,Kreher Park, and contaminated sediments - It will be conservatively assumed that construction activities could take place at every area included in this evaluation and it is possible for construction workers to be exposed to COCs detected in surface and subsurface soil samples collected from the site via incidental ingestion, inhalation (of soil borne vapor and particulates) and dermal contact pathways.

Residential Land Use Scenario: Child and Adult Residents

AC 1 – Upper Bluff - There is a residential area located up gradient from the Site on the upper bluff area, near the former ravine. For the purpose of this HHRA, child and adult residents are assumed to be exposed to COCs in surface and subsurface soil via incidental ingestion, inhalation (of soil borne vapor and particulates) and dermal contact pathways.

Recreational Use Scenario: Child, Adolescent and Adult Visitors

AC 3 – Kreher Park is now comprised of City parkland. Child, adolescent and adult visitors are assumed to be exposed to COCs in surface soil via incidental ingestion, inhalation (of soil borne vapor and particulates) and dermal contact pathways.

Exposure to COCs in Indoor Air

AC 1 – Upper Bluff - There is a residential area located up gradient from the Site on the upper bluff area, near the former ravine. For the purpose of this HHRA, child and adult residents are assumed to be exposed to COCs volatilizing from soil and groundwater and entering the residences located near the ravine.

Exposure to COCs in Surface Water and Sediments

Recreational Use Scenario: Child, Adolescent and Adult Visitors

AC-3 and 4 - Kreher park and the Bay Sediments - The site is surrounded by facilities that draw the public to the lakefront—a City marina, public swimming beach, a boat ramp and an RV park and campground. Child, adolescent and adult visitors are assumed to be exposed to COCs in surface water and sediments via incidental ingestion and dermal contact pathways while swimming, wading or boating. Inhalation pathway will not be evaluated because risks, if any, associated with the inhalation of VOCs volatilizing from seep water from the former seep area are expected to be negligible from a risk perspective.

Exposure to COCs in Fish Tissue

Recreational Use Scenario: Fishers

AC 4 – Contaminated Sediments - There are fishing activities along the lakefront. For the purpose of this risk assessment, it is conservatively assumed that fishers may be exposed to COCs in locally-caught fish via ingestion.

5.6.2.3.3 Quantification of Chemical Intakes

Integration of data gathered in the exposure assessment (i.e., the extent, frequency, and duration of exposure for the populations and pathways of concern) into a quantitative expression of chemical-specific intake is necessary to perform a quantitative risk characterization.

The potential for human receptors to be exposed to contaminated media through relevant routes of exposure (e.g., inhalation, ingestion and dermal contact) will be evaluated. Exposure pathways considered not to be applicable, based on site-specific information, will be excluded from the quantitative evaluation in the baseline risk assessment. Rationale for the elimination of exposure pathways will be provided in respective sections.

Estimates of intake of COCs are required for quantitative risk characterization. Described below is the basic equation used to calculate the human intake of COCs (USEPA, 1989):

$$I = C \times \frac{CR \times EF \times ED}{BW} \times \frac{1}{AT}$$

Where:

I	=	daily intake (mg of chemical per kg of body weight per day)
C	=	concentration of COC (e.g., mg/kg in soil, mg/L in water or mg/m3 in air)
CR	=	contact rate; the amount of contaminated medium contacted over the exposure period (e.g., mg/day for soil, L/day for water and m3/day for air)
EF	=	exposure frequency; describes how often exposure occurs (days/year).
ED	=	exposure duration; describes how long exposure occurs (years).
BW	=	body weight; the average body weight over the exposure period (kg)
AT	=	averaging time; period over which exposure is averaged (days)

Each of the intake variables in the above equation consists of a range of values in the literature. To account for uncertainties associated with parameter values, two separate exposure scenarios will be evaluated in this HHRA: a reasonable maximum exposure RME scenario and an average case (i.e., central tendency evaluation [CTE]).

General information regarding the formulae and parameter values for pathways evaluated in this HHRA is provided in the following tables in Appendix C:

Summary of Pathways Evaluated in HHRA		
Pathways	**Table Number**	
	RME	**CTE**
Industrial Worker Exposure Scenario: Inhalation of airborne COCs from surface soil Incidental ingestion of COCs in surface soil Dermal contact with COCs in surface soil	C-1	
Construction Worker Exposure Scenario: Inhalation of airborne COCs from surface and subsurface soil Incidental ingestion of COCs in surface and subsurface soil Dermal contact with COCs in surface and subsurface soil	C-2	
Maintenance Worker Exposure Scenario: Inhalation of airborne COCs from surface and subsurface soil Incidental ingestion of COCs in surface and subsurface soil Dermal contact with COCs in surface and subsurface soil	C-3	
Recreational Exposure Scenario/Children: Inhalation of airborne COCs from surface soil Incidental ingestion of COCs in surface soil Dermal contact with COCs in surface soil	C-4	
Recreational Exposure Scenario/Adolescents: Inhalation of airborne COCs from surface soil Incidental ingestion of COCs in surface soil Dermal contact with COCs in surface soil	C-5	
Recreational Exposure Scenario/Adults: Inhalation of airborne COCs from surface soil Incidental ingestion of COCs in surface soil Dermal contact with COCs in surface soil	C-6	
Recreational Exposure Scenario/Swimmer & Wade/Adolescents: Incidental ingestion of COCs in surface water Dermal contact with COCs in surface water Incidental ingestion of COCs in sediments Dermal contact with COCs in sediments	C-7	
Recreational Exposure Scenario/Swimmer & Wader: Incidental ingestion of COCs in surface water Dermal contact with COCs in surface water Incidental ingestion of COCs in sediments Dermal contact with COCs in sediments	C-8	
Recreational Exposure Scenario/Fishers: Ingestion of COCs in fish	C-9	
Off-site Residential Exposure Scenario: Inhalation of COCs in Indoor Air	C-10	

5.6.2.4 Toxicity Assessment

The toxicity assessment provides a framework for characterizing the relationship between the magnitude of exposure to a COC and the nature and likelihood of adverse health effects that may result from such exposure. Chemical toxicity is typically divided into two categories: carcinogenic and non-carcinogenic. Potential health effects will be evaluated separately for these two categories, because their toxicity criteria are based on different mechanistic assumptions and associated risks are expressed in different units. Provided in this subsection is an overview of the methodology that will be used to develop a toxicity assessment as part of the HHRA for the Site.

5.6.2.4.1 Sources of Toxicity Information

Pertinent toxicological information on COCs will be selected from the following sources, in descending order of hierarchy:

- Integrated Risk Information System (IRIS) (USEPA, 2004) - IRIS is a USEPA electronic data base containing up-to-date health risk and EPA regulatory information for numerous chemicals. IRIS contains only toxicity criteria that have been verified by the USEPA Work Groups and, consequently, is considered to be the preferred source of toxicity information. Information on IRIS always supersedes all other sources.

- USEPA Criteria Documents - Toxicity information reported in various USEPA criteria documents will be reviewed, if necessary, to retrieve chemical-specific information pertinent to the risk assessment.

- Toxicological Profiles - Toxicological Profiles developed by the Agency for Toxic Substances and Disease Registry (ATSDR), U.S. Public Health Service, will be reviewed if toxicity information is unavailable in USEPA databases or documents.

- Health Effects Assessment Summary Tables (HEAST) (USEPA, 1997a) - HEAST is a tabular presentation of toxicity information and values for specific chemicals. HEAST, which is updated periodically, also directs readers to the most current sources of supporting toxicity information through an extensive reference system. Therefore, HEAST is a useful source when verified information is not on IRIS. The latest version of the HEAST (FY 1997 Annual) will be used in this risk assessment.

5.6.2.4.2 Methodology for Evaluating Carcinogenic Effects

For purposes of assessing risks associated with potential carcinogens, the USEPA has adopted the science policy position of "no-threshold," i.e., there is essentially no level of exposure to a carcinogen which will not result in some finite possibility of tumor formation. This approach requires the development of dose-response curves correlating risks associated with given levels of exposure. Linear dose-risk response curves are generally assumed.

Carcinogenic risks associated with a given level of exposure to potential carcinogens are typically extrapolated based on slope factors or unit risks. Slope factors are the upper 95th percent confidence limit of the slope of the dose-response curve, expressed in terms of risk per unit dose [given in $(mg/kg\text{-}day)^{-1}$]. Unit risks relate the risk of cancer development with the concentration of carcinogen in the given medium, expressed as either risk per unit concentration in air [given in $(\mu g/m^3)^{-1}$] or drinking water [given in $(\mu g/L)^{-1}$].

Current USEPA Superfund guidance for calculating a dermal slope factor is to adjust the oral slope factor with an oral absorption factor specific for that chemical. It should be noted that the oral absorption factor used in the calculation refers to absorption of the constituents in the species upon which the slope factor is based; i.e., generally not absorption data in humans.
The equation for extrapolation of a default dermal slope factor is as follows:

Default Dermal Slope Factor [(mg/kg-day)-1]
= Oral Slope Factor [(mg/kg-day)-1]
÷ Oral Absorption Factor (%)

5.6.2.4.3 Methodology for Evaluating Non-carcinogenic Effects

The USEPA has adopted the science policy position that protective mechanisms (such as repair, detoxification, and compensation) must be overcome before the adverse systemic health effect is manifested. Therefore, a range of exposures exists from zero to some finite value that can be tolerated by the organism without appreciable risk of expressing adverse effects.

The approach used by the USEPA to gauge the potential non-carcinogenic effects is to identify the upper boundary of the tolerance range (threshold) for each chemical and to derive an estimate of the exposure below which adverse health effects are not expected to occur. Such an estimate calculated for the oral route of exposure is an oral reference dose (RfD), and for the inhalation route of exposure is an inhalation reference concentration (RfC). The oral RfD is typically expressed as mg chemical per kg body weight per day, and the inhalation RfC is usually expressed in terms of concentration in the air (i.e., mg chemical per m^3 of air). However, for purposes of baseline RAs, inhalation RfC values can be converted to units of dose by multiplying by the inhalation rate (20 m^3/day, an upper-bound estimate for combined indoor-outdoor activity) and dividing by the body weight (70 kg, average body weight), as detailed in the following equation:

$$\text{Inhalation Reference Dose (mg/kg-day)} = \text{RfD (in mg/m3) x 20 m3/day} \div \text{70 kg}$$

Currently, two types of oral RfDs/inhalation RfCs are available from the USEPA, depending on the length of exposure being evaluated (chronic or subchronic). Chronic oral RfDs/inhalation RfCs are specifically developed to be protective for long-term exposure to a compound, and are generally used to evaluate the non-carcinogenic effects associated with exposure periods between 7 years (approximately 10 percent of a human lifetime) and a lifetime. Subchronic oral RfDs/inhalation RfCs are useful for characterizing potential non-carcinogenic effects associated with shorter-term exposures. Current guideline for Superfund program risk assessment requires that subchronic oral RfDs/inhalation RfCs be used to evaluate the potential non-carcinogenic effects of exposure periods between 2 weeks and 7 years.

Toxicological criteria specifically derived for gauging potential human health concerns associated with the dermal route of exposure has not been developed by USEPA. For purposes of this HHRA, default dermal RfD values will be extrapolated from oral RfDs (USEPA, 1989), if:

- Health effects following exposure are not route-specific.
- Portal-of-entry effects (e.g., dermatitis associated with dermal exposure and respiratory effects associated with inhalation exposure) are not the principal effects of concern.

Exposures with the dermal route are generally calculated as absorbed doses, while oral RfDs are expressed as administered doses. Therefore, adjustments are necessary to match the dermal exposure estimates with the oral RfDs. Current USEPA Superfund guidance is to adjust the oral RfD with oral absorption factor (i.e., percent chemical that is absorbed) to extrapolate a default dermal RfD, which is expressed in terms of absorbed dose. It should be noted that the oral absorption factor used in the calculation refers to absorption of the constituents in the species upon which the reference dose is based; (i.e., generally not absorption data in humans).

The equation for extrapolation of a default RfD is as follows:

$$\text{Dermal RfD (absorbed dose in mg/kg-day)} = \text{Oral RfD (administered dose in mg/kg-day)} \times \text{Oral Absorption Factor (\%)}$$

5.6.2.4.4 Toxicological Information for COCs

Information regarding the characteristics of COCs evaluated in the HHRA will be retrieved from available sources, as described in Section 5.6.2.4.1 of this Work Plan, and presented in the RI Report.

5.6.2.5 Risk Characterization

In this step of the risk assessment, information obtained from the exposure and toxicity assessments will be integrated to characterize the potential risks posed by COCs selected for the HHRA.

5.6.2.5.1 Risk for Individual COC

The methods that will be used for characterizing risk associated with exposure to individual COCs are briefly outlined as follows:

Carcinogenic Effects

Potential risks for carcinogenic effects are typically estimated by calculating excess lifetime cancer risks (CR) as a result of exposure to carcinogens. Calculation of a CR for an exposure pathway involves multiplying the chronic daily intake for each chemical by its upper-bound cancer slope factor, as described by the following equation (USEPA, 1989):

$$CR = CDI \times SF$$

Where:

CR	=	Cancer risk (unitless)
CDI	=	Chronic daily intake of chemicals (expressed in mg/kg-day);
SF	=	Slope factor [expressed in (mg/kg-day)-1]

(Chemical-specific SF values will be used in the calculation if available, values extrapolated from a surrogate will be used, if necessary),

For known or suspected carcinogens, acceptable exposure levels are generally concentration levels that represent an excess upper-bound lifetime cancer risk to an individual of between one in ten thousand (10^{-4}) and one in a million (10^{-6}).

Non-carcinogenic Effects

Potential risks for non-carcinogenic effects are typically estimated by calculating the hazard quotient (HQ) for each COC, using the following equation:

$$HQ = \frac{CDI}{RfD}$$

Where:

CDI = Chronic daily intake of chemicals (expressed in mg/kg-day)
RfD = Reference dose (expressed in mg/kg-day); chemical-specific RfD values

will be used in the calculation if available, values extrapolated from a surrogate will be used, if necessary.

When the HQ for a COC exceeds unity (one), there may be concern for potential non-cancer effects from that COC.

5.6.2.5.2 Risk for Multiple COCs

For clarity, the methodology that will be used for characterizing risks associated with exposures to multiple chemicals is briefly outlined as follows:

1. Organize outputs of exposure and toxicity assessments by the duration and route of exposure for each population.

The total upper-bound excess lifetime CRs and the HQs will be tabulated separately for each COC.

2. Quantify total carcinogenic and non-carcinogenic risks for each pathway by summing the risks estimated for each COC.

The total upper-bound excess lifetime CR for each pathway will be obtained by summing CRs calculated for individual COCs. For known or suspected carcinogens, exposure levels that represent an excess upper-bound lifetime cancer risk to an individual of between 10^{-4} and 10^{-6} are considered to be acceptable by the USEPA.

The sum of the HQs of all COCs under consideration is termed the hazard index (HI). The HI is a useful reference point for gauging the potential non-carcinogenic effects of environmental exposures to complex exposures. In general, an HI that is less than or equal to one is regarded as not likely to be associated with any health risks, and is, therefore, less likely to be of regulatory concern as compared to hazard indices greater than one. However, a conclusion should not be categorically drawn that all HI's greater than one are "unacceptable" because of the following reasons:

-- There is perhaps one order of magnitude or greater uncertainty inherent in estimates of oral RfDs and inhalation RfCs due to the conservative approach used to derive these estimates.

-- There are uncertainties related to the assumption that individual HQs are additive.

Therefore, if the HI exceeds one, the sum of the HQs will be re-calculated by segregating the chemicals into subgroups based on the target organs affected and the mechanism of action.

3. Estimate overall risks that affect each population over the same time period by combining risks across pathways.

To address the possibility of a population that is likely to be exposed to more than one pathway, risks will be combined across different pathways that are likely to affect the same population over the same time periods.

5.6.2.6 Uncertainty Analysis

The objective of uncertainty analysis is to evaluate the assumptions and uncertainties inherent in the risk assessment to place the risk estimate in proper perspective. Presented below is an outline of the types of uncertainties that will be evaluated in this HHRA:

5.6.2.6.1 Data Evaluation

Uncertainties associated with the data validation process will be discussed to identify key issues, if any, that contribute most to the overall quality of the analytical data evaluated in the risk assessment. Because data that will be included in the baseline HHRA were collected and analyzed by different laboratories between 1990 and 2001, uncertainties relative to data comparability will also be discussed.

5.6.2.6.2 Exposure Assessment

Uncertainties associated with the findings of the exposure assessment may result from several sources. For purposes of this report, a discussion will be provided on the following types of uncertainties:

- Assumptions regarding exposure scenarios (e.g., land use, exposed populations, activity patterns);
- Applicability and assumptions of models selected to predict the fate and transport of COCs in the environment; and
- Parameter values for estimating intake of COCs.

5.6.2.6.3 Toxicity Assessment

A discussion will be provided in the report on the following sources of uncertainties associated with the results of a toxicity assessment:

- Uncertainty inherent in the standard risk assessment process
- Uncertainty common to current agency guidance on the risk assessment
- Uncertainty relative to site-specific conditions

5.6.2.6.4 Risk Characterization

Level of confidence in the results of the risk characterization will be analyzed in light of uncertainties associated with the data validation, exposure assessment and toxicity assessment in an attempt to identify the following:

- Major COCs and pathways driving the risks
- Major factors that may reduce the uncertainty associated with the results of the risk characterization

5.6.3 Baseline Ecological Risk Assessment

A description of the conduct of the Baseline ERA is included in Section 4.2.2.6

5.7 REMEDIAL INVESTIGATION REPORT

Pertinent historic data and data collected during RI/FS activities will be presented in a Remedial Investigation (RI) Report. A draft Remedial Investigation Report will be submitted to USEPA for review. Agency comments will be incorporated into the final Remedial Investigation Report. The RI report will include the following:

1) Executive Summary

2) Site Background

3) Investigation Results including a description of:
   a) Field Investigation Activities and Technical Approach;
   b) Analytical Methods and Analytical Results; and
   c) Field Methods for the collection of:
      i. Biological samples;
      ii. Surface Water samples;
      iii. Sediment Samples;
      iv. Surface and Subsurface Soil Samples;
      v. Groundwater Samples;
      vi. Indoor Air Samples;
      vii. Soil Vapor Samples; and

viii. Soil Boring, Vapor Probe, Piezometer, and Monitoring Well Installation Procedures.

4) Site Characteristics with respect to:
   a) Regional and Site Geology;
   b) Regional and Site Hydrogeology;
   c) Site Meteorologic Conditions; and
   d) Surrounding Demographics and Land Use data.

5) An Ecological Assessment

6) Nature and Extent of Contamination with respect to
   a) Contaminant Sources;
   b) Contaminant Distribution and Trends;
   c) Fate and Transport of Contaminants;
   d) Contaminant Characteristics;
   e) Contaminant Transport Processes; and
   f) Contaminant Migration Trends.

7) Human Risk Assessment that will include
   a) Hazard Identification for each source
   b) A Dose-Response Assessment
   c) A Conceptual Exposure / Pathway Analysis;
   d) Characterization of Site and Potential Receptors;
   e) Characterization of Site and Potential Receptors
   f) Exposure Assessment;
   g) Risk Characterization;
   h) Identification of Limitations and Uncertainties; and
   i) A Site Conceptual Model.

8) Ecological Risk Assessment that will include
   a) Hazard Identification for each source
   b) A Dose-Response Assessment
   c) A Conceptual Exposure / Pathway Analysis;
   d) Characterization of Site and Potential Receptors;
   e) Select Chemicals, Indicator Species, and End Points;
   f) Exposure Assessment;
   g) Toxicity Assessment and Ecological Effects Assessment;
   h) Risk Characterization;
   i) Identification of Limitations and Uncertainties; and,
   j) A Site Conceptual Model

9) Summary and Conclusions

The objective of the report will be the accurate presentation of Site conditions with respect to contaminated media, extent of contamination, and fate and transport of contaminants. Key contaminants will be selected based upon persistence and mobility in the environment and the degree of hazard. These key contaminants will be evaluated for receptor exposure to estimate contaminant levels that may reach human or environmental receptors. Water quality standards, indoor air standards, soil cleanup standards, and any other appropriate criteria accepted by the EPA will be used to evaluate potential effects on human receptors exposed to contaminants above the appropriate standards and guidelines.

5.8 DEVELOPMENT AND SCREENING OF ALTERNATIVES

At the completion of the RI report, remedial alternatives for the Site will be developed and screened. This screening will evaluate those methods that will reduce toxicity, mobility and the volume of waste to provide adequate protection of human health and the environment. Potential remedial alternatives will vary in the types of treatment, the volume treated, and long-term management of residual or untreated wastes. Potential remedial options will include options involving containment with little treatment, options involving both treatment and containment, removal and a no-action alternative.

The development and screening of potential remedial alternatives will be presented in three technical memorandums submitted to the USEPA. These technical memorandums include the following:

1) Remedial Action Objectives Technical Memorandum
2) Alternatives Screening Technical Memorandum
3) Comparative Analysis of Alternatives Memorandum

5.8.1 Remedial Action Objectives Technical Memorandum

The Remedial Action Objectives Technical Memorandum will be submitted to the USEPA within 30 days following the submittal of the Draft RI Report. This memorandum will document remedial action objectives based upon baseline human health and ecological risk assessment results. Remedial action objectives will specify the constituents of concern for each media, potential exposure pathways and receptors, and acceptable contaminant levels, or range of levels, at particular locations for each exposure route.

5.8.2 Alternatives Screening Technical Memorandum Preparation

USEPA comments to the Remedial Action Objectives Technical Memorandum will be incorporated into the Alternatives Screening Technical Memorandum. This memorandum will be submitted to USEPA within 30 days following receipt of USEPA comments to the earlier memorandum. It will include a summary of the work performed and results presented in the Remedial Action Objectives Technical Memorandum. The Alternatives Screening Technical Memorandum will document the methods and rationale of the alternatives screening process, and will include an alternatives array summary that identifies a complete and appropriate range of viable alternatives to be considered in the detailed analysis. The following tasks will be implemented in the alternatives screening process:

- Develop general response actions for each media of interest including containment, treatment, excavation, pumping, or other actions in accordance with remedial action objectives;

- Identify areas or volumes of media to which the general response actions may apply based on the chemical and physical characterization of the Site in accordance with remedial action objectives;

- Identify, screen, and document potential remedial technologies applicable for each general response action; Applicable general response actions will be refined to specify remedial technology types, and general response actions that cannot be implemented will be eliminated. Potential remedial technologies will be evaluated based upon their effectiveness, implementability, and cost; Technology types and process options will be summarized along with a preliminary list of alternatives for remedial action at the Site;

- Assemble and document representative technologies into alternative for each media; and

- Refine the remedial alternatives to identify the volumes of contaminated media addressed by the proposed processes and size critical unit operations as necessary.

5.8.3 Comparative Analysis of Alternatives Memorandum

Final screening of potential remedial responses will be completed based on long term effectiveness, implementability, relative cost. Results of this evaluation will be presented in a Comparative Analysis of Alternatives Memorandum. This evaluation will be completed to ensure that alternatives with the most favorable composite evaluation are retained for further analysis.

5.9 TREATABILITY STUDIES

Remedial alternatives screening results will determine if a treatability study for promising technologies will be needed. If treatability studies are needed, the following tasks will be completed.

- Preparation of a Candidate Technologies and Testing Needs Technical Memorandum (submitted no later than the site Alternatives Screening Technical Memorandum);
- Preparation of a Treatability Testing Work Plan and Sampling Analysis Plan;
- Preparation of a Treatability Study Health and Safety Plan; and
- Preparation of a Treatability Study Health Evaluation Report.

A description of each task follows.

5.9.1 Candidate Technologies and Testing Needs Technical Memorandum

The Candidate Technologies and Testing Needs Technical Memorandum will be prepared and submitted for Agency review no later than the time of submittal of the Alternatives Screening Technical Memorandum. It will include a list of candidate technologies for the range of technologies required for the screening analysis. Site specific requirements for the testing program will be determined during Site characterization and the development of screening of remedial alternatives. A literature search will also be completed to survey and gather information on the performance, relative costs, applicability, removal efficiencies, operation and maintenance requirements, and implementability of candidate technologies. If practical candidate technologies cannot be sufficiently demonstrated, or if such technologies cannot be adequately evaluated for this Site on the basis of available information, the USEPA may determine that treatability testing is needed.

5.9.2 Treatability Testing Work Plan and Sampling Analysis Plan

The USEPA will use information presented in the Candidate Technologies and Testing Needs Technical Memorandum to determine if treatability testing is needed, and notify Xcel Energy. If it is needed, USEPA will also decide on the type of treatability testing (e.g. bench versus pilot) to use. Xcel Energy will submit a statement of work for Agency review within 30 days of this notice. The statement of work will outline the steps and the data necessary to evaluate and initiate the treatability testing program.

Within 30 days of a request by USEPA, Xcel Energy will prepare and submit a Treatability Testing Work Plan and Sampling and Analysis Plan, or amend the original RI/FS Work Plan, FSP, and QAPP for Agency review. It will include a description of the Site background, the remedial technologies to be tested, test objectives, experimental procedures, treatability conditions to be tested, measurements of performance, analytical methods, data management and analysis, residual waste management, and data quality objectives for treatability testing. Pilot plant installation, start-up, operation, and maintenance procedures, a description of operating conditions to be tested, and a sampling plan to evaluate the performance of the pilot test will be included in the Work Plan if a pilot scale treatability test is to be completed.

5.9.3 Treatability Study Health and Safety Plan

A separate or amended Health and Safety Plan will be submitted for Agency review for activities performed during treatability tests.

5.9.4 Treatability Study Evaluation Report

A Treatability Study Evaluation Report will be prepared following the completion of the treatability study and submitted for Agency review either as a part of the RI Report, or as a separate submittal. Testing results will be used to evaluate each technology's effectiveness, implementability, costs, and actual results compared to predicted results. The report will include an evaluation of the full scale implementation of the technology. A sensitivity analysis identifying key parameters affecting full-scale operation will also be included.

5.10 DETAILED ANALYSIS OF ALTERNATIVES – FEASIBILITY STUDY REPORT

5.10.1 Comparative Analysis of Alternatives Technical Memorandum

A Comparative Analysis of Alternatives Technical Memorandum will be prepared to address USEPA's comments to the Alternatives Screening Technical Memorandum. The Comparative Analysis of Alternatives Memorandum will include a comparison between remedial alternatives using the following nine criteria:

1. The overall protection of human health and the environment, and how each alternative meets each of the remedial action objectives;
2. Compliance with ARARs;
3. Long-term performance effectiveness and performance;
4. Reduction of toxicity, mobility, or volume of contamination;
5. Short-term effectiveness;
6. Implementability;
7. Cost;
8. State acceptance; and
9. Community acceptance.

This evaluation will include a discussion of the above individual criterion for each potential remedial response, and a detailed description of each remedial response.

5.10.2 Feasibility Report

A Feasibility Report will be prepared to incorporate USEPA's comments on the Comparative Analysis of Alternatives Technical Memorandum within 45-days after receipt of these comments. The Feasibility Report will summarize the development and screening of the remedial alternatives and present the detailed analysis of remedial alternatives. It will also include information USEPA may need to prepare relevant sections of the Record of Decision (ROD).

5.11 PROGRESS REPORTS

In accordance with the November, 2003 AOC, Xcel Energy will submit monthly progress reports to USEPA on the 15th of each month, or on the closest Monday should the 15th fall on a Saturday or Sunday. These status reports will terminate at the completion of the AOC, or if directed by the USEPA in writing. Each report will include, but may not be limited to a description of all significant developments during the preceding calendar month, and will include the following;

- A description of work performed including any problems that were encountered;
- A summary of the analytical data that was received during the reporting period;
- The developments anticipated during the next reporting period;
- A schedule for work to be performed;
- Anticipated problems, and actual or planned resolutions of past or anticipated problems;
- A summary of completed field activities during the reporting period, and description of upcoming field activities; and
- A description of any modifications to procedures outlined in the RI/FS Work Plan, FSP, QAPP, or Health and Safety Plan with justification for these modifications.

Soil boring logs, sample collection logs, and field notes will be included with monthly status reports as needed.

6.0 SCHEDULE

Appendix E is a timeline for implementation of the previously described RI/FS activities. The schedule is based on the requirements defined in the Administrative Order on Consent. The schedule begins with the November 14, 2003 effective date of the AOC and is carried through submittal of the Feasibility Study Report. Submittal of the FS is represented with two different dates. If Treatability Studies are not performed, the final FS report approval is projected to occur in early May, 2006. If Treatability Studies are performed, the final FS report approval is projected for early September, 2007. Reasonable Agency review periods for all deliverables are shown. The schedule also assumes seasonal limitations caused by the Site's location on Lake Superior.

The schedule compares the difference in timelines between the implementation of the Alternative 1 sediment sampling program compared to implementation of the Alternative 2 program. (Note that Appendix E also includes a proposed agenda for the first stakeholder workshop to be held as part of the Alternative 2 Problem Formulation process.) As shown, there is no difference in the submittal date of the draft RI report; the 2004 field season is utilized for sampling with either Alternative. As stated previously, Xcel Energy suggests that USEPA consider approving Alternative 2.

7.0 PROJECT MANAGEMENT

In accordance with the AOC, a Project Coordinator, Contractor, and Remedial Project Manager has been assigned to the Site. A description of each assignment follows.

Project Coordinator

Mr. Jerry Winslow of Xcel Energy will serve as project coordinator. Mr. Winslow has been involved with the project since August of 2000. He will be responsible for administration of all actions required of Xcel Energy by the USEPA and the WDNR. Contact information for Mr. Winslow is as follows:

Jerry C. Winslow
Xcel Energy
414 Nicollet Mall (RS-8)
Minneapolis , Minnesota 55401
(612) 330-2928
(612) 330-6357 Fax
jerry.c.winslow@xcelenergy.com

With copies to:

David A, Crass, Esq.
Michael Best & Friedrich LLP
P.O. Box 1806
Madison, Wisconsin 53701-1806
(608) 283-2267
(608) 283-2275 Fax
dacrass@mbf-law.com

Contractor

URS Corporation (URS) has been designated as the contractor for the project. URS (formerly known as Dames & Moore) has been involved with the Xcel Energy property since January 1995. URS will be responsible for completing the technical requirements required of Xcel Energy by the USEPA and the WDNR. Mr. Bert Cole of URS will serve as URS project coordinator. Mr. Dave Trainor of NewFields will serve as Project Manager as a subcontractor to

URS. Dr. Weldon Bosworth of URS will serve as Senior Project Scientist, and will be responsible for directing the ecological risk assessment as well as studies relating to sediment stability and contaminant fate and transport of AC 4. Contractor roles and responsibilities, including subcontractor services, are described in detail in the PMP. Contractor contact information is as follows:

Bert Cole
URS Corporation
54 Park Place, Suite 950
Appleton, Wisconsin 54914
(920) 968-6900
(920) 968-6940 Fax
bert_cole@urscorp.com

Dave Trainor
NewFields
2110 Luann Lane, Suite 101
Madison, Wisconsin
(608) 442-5223
(608) 442-9013 Fax
dtrainor@newfields.com

Weldon Bosworth
URS Corporation
45 Hillside Drive
Gilford, NH 03249
(603) 524-1822
(603) 528-9674 Fax
wbosworth@metrocast.net

Curriculum vitae for Mr. Trainor, Mr. Cole, and Dr. Bosworth are included as Appendix F.

Remedial Project Manager

Ms. Sharon Jaffess of the Region 5 Remedial Response Branch of the USEPA will serve as Remedial Project Manager (RPM). Mr. Jamie Dunn of the WDNR will serve as the WDNR's Project Manager (WDNR PM). All documents required of Xcel Energy by the USEPA will be submitted to the RPM, and a copy will be submitted to the WDNR PM. Contact information for USEPA is as follows:

Sharon Jaffess
Remedial Project Manager
United States Environmental Protection Agency – Region 5
77 West Jackson Blvd.. Mail Code SR-6J
Chicago, Illinois 60604-3590
(312) 353-1264
(312) 886-4071 Fax
jaffess.sharon@epa.gov

AND

Jamie Dunn
Project Manager
Wisconsin Department of Natural Resources
810 West Maple Street
Spooner, Wisconsin 54801
(715) 635-4049
(715) 635-4105 Fax
james.dunn@dnr.state.wi.us

8.0 REFERENCES

NOTE: A listing a all documents presenting results from previously completed site activities is included in Section 2.1.4 of this report.

Geology of Wisconsin and Upper Michigan, Rachel Krebs Paull and Richard A. Paull, 1977.

Health Information for Hazardous Waste Sites, Ashland/Northern States Power Lakefront Site, City of Ashland, Wisconsin. Update – January 2000. Prepared by the Wisconsin Department of Health and Family Services, Division of Public Health.

Health Information for Hazardous Waste Sites, Ashland/Northern States Power Lakefront Site, City of Ashland, Wisconsin. Update – January 2000. Prepared by the Wisconsin Department of Health and Family Services, Division of Public Health.

Fact Sheet. A History of the Ashland/Northern States Power Lakefront Site – June 2001. Prepared by the Wisconsin Department of Natural Resources.

Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA. EPA/540/G-89/004. October 1998. USEPA (U.S. Environmental Protection Agency).

Ecological Risk Assessment for Superfund: Process for Designing and Conducting Ecological Risk Assessments, Interim Final. 1997. Environmental Response Team, Edison, NJ. USEPA (U.S. Environmental Protection Agency).

Guidance for Ecological Risk Assessment. 1998. USEPA (U.S. Environmental Protection Agency).

Guidance for the Data Quality Objective Process. EPA QA/G-4. August 2000. USEPA (U.S. Environmental Protection Agency).

Evaluating The Vapor Intrusion To Indoor Air Pathway From Groundwater and Soils. December 2001. USEPA (U.S. Environmental Protection Agency).

NOTE: The following references refer to the ecological studies.

Barbour, M.T., Gerritsen, J., Snyder, B.D., and Stribling, J.B., 1999, Rapid Bioassessment Protocols for use in streams and wadeable rivers: Periphyton, benthic macroinvertebrates, and fish, Second edition: EPA 841-B-99-002. Office of Water, U.S. Environmental Protection Agency, Washington, D.C.

Chapman P.M., Dexter, R.N., and E.R. Long. 1987. Synoptic measures of sediment contamination, toxicity, and infaunal community composition (the Sediment Quality Triad) in San Francisco Bay. Mar. Ecol. Prog. Series 37:75-96

Chutter, F.M. and R.G. Noble. 1966. The reliability of a method of sampling stream invertebrates. Arch. Hydrobiol. 62(1):95-103.

Glenn, Scott M. and Grant, William D. "A Suspended Sediment Stratification Correction for Combined Wave and Currents Flows", Journal of Geophysical Research, Vol 92, No. C8, pp. 8244-8264, July 15, 1987

Long, E.R. and P.M. Chapman. 1985. A Sediment Quality Triad: Measures of sediment contamination, toxicity, and infaunal community composition in Puget Sound. Marine Pollution Bulletin. 16:405-415.

Madsen, Ole, "Mechanics of Coastal Sediment Transport Processes: Short Course Notes from Coastal Sediments 1999", Specialty ASCE Conference, 147 pp.

Mason, W.T., Weber, C.I., Lewis, P.A., and E.C. Julian. 1973. Factors affecting the performance of basket and multiplate macroinvertebrate samplers. Freshwater Biology 3:409-436.

Rediske, R., Gabrosek, J., Thompson, C., Bertin, C., Blunt, J., and P. Meier. 2001. Preliminary investigation of the extent of sediment contamination in Manistee Lake. Great Lakes national Program Office, U.S. Environmental Protection Agency.

Rediske, R., Thompson, C., Schelske, C., Gabrosek, J., Nalepa, T. and G. Peaslee. 2002. Preliminary investigation of the extent of sediment contamination in Muskegon Lake. Great Lakes national Program Office, U.S. Environmental Protection Agency.

Schwenneker, B.W. and R.A. Hellenthal. 1984. Sampling considerations in using stream insects for monitoring water quality. Environmental Entomology 13:741-750.
SEH. 1998a. Ecological Risk Assessment. Ashland Lakefront Property – Contaminated Sediments. October 1998.

SEH. 1998b. Ecological Risk Assessment. Problem Formulation. April 1998.

SEH. 2002. Ecological Risk Supplement. Ashland Lakefront Property – Contaminated Sediments. February 2002.

SEH. 2003. Remedial Investigation Work Plan: Ashland/NSP Lakefront Site, Ashland, WI. October 2003.

URS 2001. Sediment Sample Results – NSP /Ashland Lakefront. June, 2001

URS. 2003. "Straw Man" Baseline Problem Formulation: DRAFT. URS Corporation. March 2003.

USEPA. 1990. Macroinvertebrate Field and Laboratory Procedures for Evaluating the Biological Integrity of Surface Waters. U.S. Environmental Protection Agency, Office of Research and Development. EPA/600/4-90/030.

USEPA. 1997. Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessment, EPA/540-R-97-006.

USEPA. 1998. Guidance for Ecological Risk Assessment. U.S. Environmental Protection Agency. EPA/630/R-95/002F

USEPA. 2000a. Data Quality Objectives Process for Hazardous Waste Site Investigations. U.S. Environmental Protection Agency, Office of Environmental Information. EPA QA/G-4HW.

USEPA. 2000b. Methods for Measuring Toxicity and Bioaccumulation of Sediment-associated Contaminants with Freshwater Invertebrates: Second Edition. U.S. Environmental Protection Agency, Office of Research and Development. EPA 600/R-99/064.

USEPA. 2001. Planning for Ecological Risk Assessment: Developing Management Objectives. External Review Draft. EPA/630/R-01/001A.

USEPA. 2002. DRAFT Contaminated Sediment Remediation Guidance for Hazardous Waste Sites. U.S. Environmental Protection Agency. OSWER 9355.0-85.

Borenstein, M., H. Rothstein, and J. Cohen. 1997. SamplePower 1.0. Chicago, SPSS Inc.

Cohen, J. 1977. Statistical Power Analysis for the Behavioral Sciences. New York, Academic Press.

Dallal, G., M. Pechnyo, and R. Marcantonio. 2000. Power Analysis. in SYSTAT 10: Statistics II. Chicago, SPSS Inc.

Krebs, C. 1999. Ecological Methodology, 2nd ed. Menlo Park CA, Benjamin/Cummings.

Magurran, A. 1988. Ecological Diversity and Its Measurement. Princeton NJ, Princeton U. Press.

Potvin, C. and D. Roff. 1993. Distribution-free and robust statistical methods: alternatives to parametric statistics. Ecology 76:1617-1629.

Preston, F. 1962. The canonical distribution of commonness and rarity. Ecology 43:185-215 and 410-32.

NOTE: The following references refer to the human health risk assessment.

Gilbert, R.O., 1987. Statistical Methods for Environmental Pollution Monitoring. Von Nostrand Reinhold, New York.

USEPA, 1989. Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual. Part A. Interim Final, December 1989. EPA/540/1-89/002. (hereafter referred to as "RAGS, Part A".)

USEPA, 1990. Technical Support Document for Lead. Prepared by Syracuse Research Corporation under Contract to the Environmental Criteria and Assessment Office, Cincinnati, Ohio.

USEPA, 1991. Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual, Part B, Development of Risk-based Preliminary Remediation Goals. Interim Final. EPA/540/R-92/003. (RAGS, Part B).

USEPA, 1992a. Supplemental Guidance to RAGS; Calculating the Concentration Term. Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-081.

USEPA 1992b. Dermal Exposure Assessment: Principles and Applications. Interim Report. Office of Research and Development, Washington, D.C. EPA/600/8-91/001B.

USEPA 1992c. Guidance on Risk Characterization for Risk Managers and Risk Assessors. Memorandum from F. Henry Habicht II, Deputy Administrator to Assistant Administrators. Regional Administrators. February 26, 1992.

USEPA, 1994. Guidance on Residential Lead-based Paint, Lead Contaminated Dust, Lead Contaminated Soil. Washington, D.C. July 14, 1994.

USEPA, 1996. Soil Screening Guidance. Office of Solid Waste and Emergency Response.

USEPA, 1997a. Health Effects Assessment Summary Tables (HEAST), FY 1997 Update. July 1997. NTIS PB97-921199.

USEPA, 1997b. Exposure Factors Handbook. National Center for Environmental Assessment. August 1997.

USEPA, 2002. Region 9 Preliminary Remediation Goals (PRGs). USEPA, Region 9.

Davidson, A.C., and D.V. Hinkley. 1997. *Bootstrap Methods and their Application.* Cambridge Series in Statistical and Probabilistic Mathematics. Cambridge University Press, Cambridge, UK.

Efron, B. and G. Gong. 1983. A leisurely look at the bootstrap, the jackknife, and cross-validation. Am. Statistician. 37:36-48

EPA. 1992a. *Supplemental Guidance to RAGS: Calculating the Concentration Term*. Publication 9285.7-081, May.

EPA. 1992b. *Guidance for Data Usability in Risk Assessment (Part A). Final*. OERR 9285.7-09A. April, 1992.

EPA. 1997. *The Lognormal Distribution in Environmental Applications*. Publication EPA/600/R-97/006, December.

Kelly, P.A. 1999. Overview of computer intensive statistical inference procedures. Educational Research – Measurement and Statistics, Florida State University, February 1999.

Kilian, L. 1998. Pitfalls in constructing bootstrap confidence intervals for asymptotically pivotal statistics. Econometrics. 4:1-34

Schulz, T.W. and Griffin, S., 1999. "Estimating Risk Assessment Exposure Point Concentrations When the Data Are Not Normal or Lognormal," *Risk Analysis*. Vol. 19, No. 4, pp.577-584.

NOTE: The following references refer to the sediment stability studies.

American Society of Civil Engineers (ASCE), 1976. Design and Construction of Sanitary and Storm Sewers.

Bhowmik, N. G., 1975, Boat-Generated Waves in Lakes, Journal of the Hydraulics Division, ASCE, Vol. 101, No. HY11.

Chow, V. T., 1959. Open-Channel Hydraulics, McGraw-Hill Book Company, New York, NY.

Davis, C.V. and Sorensen, K. E., 1970. Handbook of Applied Hydraulics, McGraw-Hill Book Company, New York, NY.

Einstein, H. A., 1950. The Bed-Load Function of Sediment Transportation in Open Channel Flows, Tech. Bulletin No. 1026 September 1950, US Department of Agriculture, Soil Conservation Service, Washington, D.C.

Fischer, H.B., List, J. E., Koh, R.C.Y., Imberger, J., and Brooks, N.H., 1979, Mixing in Inland and Coastal Waters, Academic press, New York.

Glenn, Scott M. and Grant, William D. "A Suspended Sediment Stratification Correction for Combined Wave and Currents Flows", Journal of Geophysical Research, Vol 92, No. C8, pp. 8244-8264, July 15, 1987.

Limerinos, J.T. and W. Smith, 1975, Evaluation of the Causes of Levee Erosion in the Sacramento-San Joaquin Delta, California, Water Resources Investigations 28-74, U.S. Geological Survey.

Madsen, Ole, "Mechanics of Coastal Sediment Transport Processes: Short Course Notes from Coastal Sediments 1999", Specialty ASCE Conference, 147 pp.

McNeil, J., Taylor, C., and Lick, W. 1997. Measurements of Erosion of Undisturbed Bottom Sediments with Depth. .Journal of Hydraulic Eng., 122, 6. Pp.316-324.

Pacific International Engineering. 2000. Propwash modeling for Confined Aquatic Disposal Design. Massachusetts Institute of Technology Department of Civil and Environmental Engineering, Dredged Material Management: Options and Environmental Considerations Conference. Presentation by: Shepsis, V. and Simpson, D.J.

Pacific International Engineering. 2001. Vessel-generated bottom velocities at the Port of Bellingham. Technical Memorandum for the Port of Bellingham. January 2001.

SEH. 1998. Ecological Risk Assessment. Ashland Lakefront Property – Contaminated Sediments. October 1998.

SEH. 2002. Ecological Risk Supplement. Ashland Lakefront Property – Contaminated Sediments. February 2002.USEPA (U.S. Environmental Protection Agency). 2002.

Simons, D. B. and Senturk, F., 1976. Sediment Transport Technology, Water Resources Publications, Fort Collins, CO.

Singh, B., 1967. Fundamentals of Irrigation Engineering, Nem Chand & Bros., Roorkee, India.

URS 2001. Sediment Sample Results – NSP /Ashland Lakefront. June, 2001

U.S. Army Corps of Engineers (USACE), 1984, Shore Protection Manual, Waterways Experiment Station, Coastal engineering Research Center, Washington, D.C.

U. S. Bureau of Reclamation (USBR), 1984. Computing Degradation and Local Scour, Denver, CO.

U. S. Department of Agriculture (USDA), 1986, Urban Hydrology for Small Watersheds, Technical Release No. 55, Soil Conservation Service, Washington, D.C.

USEPA. 2002. DRAFT Contaminated Sediment Remediation Guidance for Hazardous Waste Sites. OSWER 9355.0-85.

U.S. Geological Survey (USGS), 1994, Nationwide Summary of USGS Regional Regression Equations for estimating Magnitude and frequency of Floods for Ungaged Sites, 1993 Water Resources Investigations Report, 94-4002, Reston, VA.

Ziegler, C. K. and B. Nisbet, 1994, Fine-Grained Sediment Transport in Pawtuxet River, Rhode Island, Journal of Hydraulic Engineering, ASCE, Vol. 120, No. 5, May 1994.

Ziegler, C.K., 1999, Sediment Stability at Contaminated Sites, Fall 1999 Report, Quantitative Environmental Analysis, LLC (QEA), Montvale, NJ.

Ziegler, C.K., 2002, Evaluating Sediment Stability at Sites with Historic Contamination, Environmental Management, Vol. 29, No. 3, pp. 409-427, 2002 Springer-Verlag New York, Inc.

Tables

Table 1
RI / FS Work Plan
Ashland / NSP Lakefront Superfund Site - Ashland, Wisconsin
Analyte List for Soil, Sediment, and Groundwater Samples

Analyte	Analyte	Analyte
VOCs	**SVOCs**	**Inorganics**
Benzene	Acenaphthene	Arsenic
sec-Butylbenzene	Acenaphthylene	Aluminum
Ethylbenzene	Anthracene	Antimony
Styrene	Benzo(a)Anthracene	Barium
Toluene	Benzo(a)Pyrene	Beryllium
1,2,3-Trimethylbenzene	Benzo (e) Pyrene	Cadmium
1,2,4-Trimethylbenzene	Benzo(b)Fluoranthene	Calcium
1,3,5-Trimethylbenzene	Benzo (k) Fluoranthene	Chromium (+3)
Total Xylenes	Benzo(g,h,i)Perylene	Chromium (+6)
	Chrysene	Cobalt
	Dibenzo(a,h)Anthracene	Copper
	Fluoranthene	Cyanide
	Fluorene	Iron
	Indeno(1,2, 3-cd)Pyrene	Lead
	1-Methyl Naphthalene	Magnesium
	2-Methyl Naphthalene	Manganese
	Naphthalene	Mercury
	Phenanthrene	Nickel
	Pyrene	Potassium
	Dibenzofuran	Selenium
	Phenol	Silver
	2-Methyl Phenol	Sodium
	3-Methyl Phenol	Thallium
	4-Methyl Phenol	Vanadium
		Zinc

Table 2
RI / FS Work Plan
Ashland / NSP Lakefront Superfund Site - Ashland, Wisconsin
Analyte List for TO15 Air Samples

VOCs
1,1,1-Trichloroethane
1,1,2,2-Tetrachloroethane
1,1,2-Trichloroethane
1,1-Dichloroethane
1,1-Dichloroethene
1,2,4-Trichlorobenzene
1,2,4-Trimethylbenzene
1,2-Dibromoethane (EDB)
1,2-Dichlorobenzene
1,2-Dichloroethane
1,2-Dichloropropane
1,3,5-Trimethylbenzene
1,3-Dichlorobenzene
1,4-Dichlorobenzene
Benzene
Benzyl chloride
Bromomethane
Carbon tetrachloride
Chlorobenzene
Chloroethane
Chloroform
Chloromethane
cis-1,2-Dichloroethene
cis-1,3-Dichloropropene
Dichlorodifluoromethane
Ethylbenzene
Hexachlorobutadiene
m-Xylene
o-Xylene
p-Xylene
Methylene chloride
Styrene
Tetrachloroethene
Toluene
trans-1,3-Dichloropropene
Trichloroethene
Trichlorofluoromethane
Vinyl chloride

Figures

Appendices

Appendix A

Contaminant Distribution Maps for Chequamegon Bay Inlet

Appendix B

Site Geographic Information System (GIS) Database Platform – Examples

Appendix C

Human Health Risk Assessment Tables

Appendix D

Power Analysis Results

One Way ANOVA (alpha=0.05)s

Appendix E

Ashland/NSP Lakefront Superfund Site
RI/FS Schedule

Appendix F

Curriculum Vitae for Project Personnel